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Title: APPARATUS AND METHOD FOR LOAD BALANCING AMONG DATA COMMUNICATIONS PORTS IN AUTOMATED SECURITIES TRADING SYSTEMS	§	Docket No.:	T30411US

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TRANSMITTAL LETTER

Transmitted herewith for filing in the above-identified case are the following documents:

X Twenty-nine (29) pages of Specification, including twenty (20) claims and one (1) Abstract page;

X Thirteen (13) sheets of *Informal* drawings (Figs. 1-13);

X Twenty-one (21) pages representing Appendix I;

X Combined Declaration and Power of Attorney;

X Verified Statement Claiming Small Entity Status (37 C.F.R. 1.9(f) & 1.27(c);

X Assignment Recordation Coversheet *with* Original Assignment;

X Check in the amount of $345.00 to cover the Application Filing fee;

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The Commissioner is hereby authorized to charge any deficiency or credit any overpayment required under 37 CFR §§ 1.16 – 1.17 to Deposit Account No. 01-2511. A duplicate copy of this transmittal is enclosed for this purpose.

Respectfully submitted,

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VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS
(37 CFR 1.9(f) & 1.27(c)) - SMALL BUSINESS CONCERN

Applicant or Patentee: Amanat, I., and Bundy, M.
Serial or Patent No.: *Unassigned*
Filed or Issued: Filed Herewith
Title: Apparatus and Method for Load Balancing Among Data Communications Ports In Automated Securities Trading Systems

I hereby declare that I am

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☒ an official of the small business concern empowered to act on behalf of the concern identified below.

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Apparatus and Method for Load Balancing Among Data Communications Ports In Automated Securities Trading Systems
(Title of the Invention)

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SIGNATURE [signature] DATE June 22, 2000

APPLICATION FOR PATENT

TITLE: APPARATUS AND METHOD FOR LOAD BALANCING AMONG DATA COMMUNICATIONS PORTS IN AUTOMATED SECURITIES TRADING SYSTEMS

INVENTORS: IRFAN AMANAT
MICHAEL BUNDY

ATTORNEY DOCKET NUMBER: 30411US

SPECIFICATION

BACKGROUND

Broker-dealer systems for automated trading of securities need to be fast. Broker-dealer systems receive orders from customers, send the orders to markets, receive responses from markets, and communicate order status to customers. Orders are sent to markets through data communications ports. Responses are received from markets through data communications ports. Ports are dedicated to particular markets. Data communications ports have limitations upon the number of orders that can be sent through them in a particular period of time or the number of orders without acknowledgments that can be sent through them. If more orders arrive than can be sent through a port in a particular period of time, the broker-dealer system is slowed. If a port partially fails or is slowed for mechanical or electrical reasons, the broker-dealer system is slowed. If a port fails completely, the broker-dealer system is disabled with regard to the market served by that port.

Broker-dealers often add additional ports to their systems, so that more than one port is dedicated to a particular market. Adding ports improves overall throughput of orders to markets and reduces the risk of being completely disabled with respect to a market if a port fails. System performance can still vary widely, however, from the point of view of a customer whose order is sent through a port that is slowed or stopped by overload or mechanical failure. Such a customer experiences the harmful effect of a lack of balance in the communications load among the ports for the market to which the customer's order was intended. Methods and systems are needed for balancing the communications loads among ports for markets in support of the overall quality of data communications in broker-dealer systems.

SUMMARY

A first aspect of the invention provides methods of balancing data communications loads among data communications ports in systems for automated trading of securities. The systems for trading securities include at least one broker-dealer system coupled through at least one data communications system to more than one market system. Data communications systems include ports organized so that one market is coupled to the broker-dealer system through more than one port. Embodiments of the invention include methods of load balancing applied when a new order from the broker-dealer system is available and ready to be sent through a port to a market. The inventive methods in typical embodiments are applied continually in turn to each port assigned to a market.

Embodiments of load balancing methods typically include the steps of receiving acknowledgments of orders previously sent through a port from a broker-dealer system to a market, sending acknowledgments to the broker-dealer system, and determining that port are not overloaded. Various embodiments of the present invention make determinations of overload on the basis of latency, net order count, or order count

compared with acknowledgment count.

Alternative embodiments of the invention send orders only through least-loaded ports. Least-loaded ports are identified on the basis of latency, net order count, or a combination of the two.

A second aspect of the invention provides a load balancing system for automated trading of securities in which data communications loads are balanced among data communications ports. Embodiments of a load balancing system are typically coupled to a multiplicity of ports organized so that one market is coupled to a broker-dealer system through more than one port. Embodiments of a load balancing system typically function when a new order from a broker-dealer system is available and ready to be sent through a port to a market. Embodiments of a load balancing system are typically operative continually in turn upon each of the ports assigned to a market.

Embodiments of the load balancing system typically comprise at least one computer processor coupled for data communications to at least one broker-dealer system and coupled through data communications ports to more than one market. In typical embodiments, the processor is programmed to receive through a port from a market to which the port is coupled a new acknowledgment of an order previously sent through the port from the broker-dealer system to the market. The processor in typical embodiments is programmed to send the new acknowledgment to the broker-dealer system.

The processor in typical embodiments of this second aspect of the invention is programmed also to determine that the port is not overloaded, with overload being determined according to measures of latency, net order count, or order count and acknowledgment count. The processor in most embodiments is programmed also to send a new order through the port to the market. Many embodiments of the load balancing system include computer memory coupled to the processor with the processor

programmed also to store in computer memory the new acknowledgment and the new order.

In many embodiments of the invention, the processor is programmed also to send orders to markets only through least-loaded ports. Processors are typically programmed to determine that a port is least loaded dependent upon latency, net order count, or a combination of latency and net order count.

DRAWINGS

Figure 1 is an overview of a first aspect of the invention, a method of load balancing.

Figure 2 is a detailed data flow view of various embodiments of the invention.

Figure 3 illustrates a determination of no overload by determining that latency is less than the maximum allowed.

Figure 4 illustrates a determination of no overload by determining that a net order count is less than a maximum net order count.

Figure 5 is an example port data structure.

Figure 6 illustrates a determination of no overload by determining that an order count exceeds an acknowledgment count by less than a maximum net order count.

Figure 7 illustrates alternative embodiments effecting load balancing by use of least-loaded ports.

Figure 8 is an overview of a second aspect of the invention, a load balancing system.

Figure 9 is a detailed structure view of various embodiments of the invention.

Figure 10 illustrates a processor programmed for a determination of no overload by determining that latency is less than the maximum allowed.

Figure 11 illustrates a processor programmed for a determination of no overload by determining that a net order count is less than a maximum net order count.

Figure 12 illustrates a processor programmed for a determination of no overload by determining that an order count exceeds an acknowledgment count by less than a

maximum net order count.

Figure 13 illustrates alternative embodiments with a processor programmed to effect load balancing by use of least-loaded ports.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Definitions:

"Acknowledgment" is a response from a market in which an order has been placed, the response being a confirmation that an order has been received by the market.

"Coupled," except when context requires otherwise, means coupled for data communications. This is particularly the case when describing broker-dealer systems as being coupled to markets through data communications ports. Broker-dealer systems typically are coupled to ports, which ports in turn typically are coupled to markets. Methods of coupling for data communications useful with the invention include all forms of data communications networks, intranets, extranets, internets, local area networks, wide area networks, dedicated lines, satellite links, and the like. Any functional method of data communications is well within the scope of the invention.

"ECN" abbreviates "Electronic Communications Network," referring to an order matching service that provides liquidity by matching orders rather than by maintaining inventory. In the context of the invention, ECNs are considered markets. ECNs, like market makers are identified by use of market participant identification codes or "MPIDs." In order to avoid confusion with data communications networks, ECNs are referred to as either "ECNs" or as "markets." Some current ECNs, their symbols and names, are listed below. The number and identities of ECNs changes from time to time.

Example List of ECNs	
MPID	**Name**
ARCA	Archipelago
BTRD	Bloomberg Trade Book
INCA	Instinet
ISLD	Island
MWSE	Midwest Stock Exchange
NTRD	NexTrade
REDI	Speer Leeds

"Exchange" means a national, regional, or international exchange for securities trading including for example, Nasdaq or NYSE.

"Execution," is a kinds of response to an order from a market, the execution indicating that the order has been at least partly filled, that is, that shares have been either bought or sold according to the side of the order.

"Filled" means executed. That is, all shares in the order have been executed, bought or sold according to the side of the order. If an order is subject to partial fulfillment, then the order can be partly filled and partly rejected or cancelled, in which case the order will never be considered filled. Processing of an order can therefore be completed through some combination of cancellation, rejection, killing, and partial execution without the order's ever being filled. Processing of an order is said to be complete when all the shares in the order, share by share, have been executed, cancelled, rejected, or killed.

"Latency" means a measure of the speed with which markets respond to orders and cancellations. Latency in many embodiments of the invention is determined as the difference between the time when a response to an order is received and the time when the corresponding order was routed to the market. Latency can be measured from normal orders or from test orders. Some markets support test orders as such. For markets in which test orders as such are not supported, test orders can be implemented by use of unmarketable orders immediately followed by cancellations. For markets receiving orders regularly, latency can be tracked from normal orders, without the need for test orders. Latency can be embodied as a single ratio difference between two recorded times or as various kinds of averages. One type of average latency useful with the invention is a moving average latency, a latency in which the average is dependent upon a number of recorded times for orders and acknowledgments, the times being recorded during a defined period of time, such as, for example, one trading day. Another type of average latency useful with the invention is a decaying average latency, in which the average is dependent upon a set number N of recorded times for orders and acknowledgments, the set number defining the N most recently recorded times. Other kinds of average latencies can be used, all of them being well within the scope of the invention.

"Level Two Quotes" are quotes that comprise one or more market participant quotes ("MPQs"). The best known source of level two quotes is Nasdaq, but "level two quotes" refers to any form of market information that aggregates market participant quotes for a security.

"Market," "electronic market," "market participant," "electronic market participant," "marketing network," "electronic communications network," "ECN," "exchanges," and "electronic marketing network" are all used as synonyms for services accessible through electronic communications networks capable of executing orders for securities by accepting from broker-dealers buy orders and sell orders, matching or failing to match

buy orders with sell orders, and communicating the results to the broker-dealers. Generally the term "market" is used to refer to these entities.

"Market maker" means a broker-dealer providing order matching and liquidity in a stock by maintaining an inventory of the stock. Market makers typically trade their inventories through exchanges. Some currently active market makers, their symbols and names, are listed below. The number and identity of market makers can change from time to time.

Example List of Market Makers

MPID	Name
BEST	Bear, Stearns & Co., Inc.
BTAB	Alex, Brown & Sons, Inc.
GSCO	Goldman, Sachs & Co.
HMQT	Hambrecht & Quist, LLC
HRZG	Herzog, Heine, Geduld, Inc.
JANY	Janney Montgomery Scott, Inc.
LEHM	Lehman Brothers, Inc.
MADF	Bernard L. Madoff
MLCO	Merrill Lynch, Pierce, Fenner & Smith Inc.
MOKE	Morgan, Keehan & Co., Inc.
MONT	Nationsbanc Montgomery Securities, LLC
MSCO	Morgan Stanley & Co., Inc.

NITE	Knight Securities, L.P.
OLDE	Olde Discount Corporation
OPCO	CIBC Oppenheimer Corporation
PIPR	Piper Jaffray Inc.
PRUS	Prudential Securities, Inc.
PWJC	Paine Webber, Inc.
RAJA	Raymond James & Associates, Inc.
SBSH	Smith Barney, Inc.
SHRP	Sharpe Capital, Inc.
SHWD	Sherwood Securities Corporation

"Orders" are orders for purchase or sale of securities. In the embodiments described, "orders" are electronic orders for purchase or sale of securities.

"Quotes" are aggregates of information regarding securities traded in markets. Quotes include for securities listed for sale or purchase, symbols identifying the securities, price, side, quantities, and market identifications or MPIDs. Quotes can come from exchanges or directly from markets. A "Nasdaq Level Two Quote" includes market information in the form of market participant quotes for all markets offering to buy or sell a particular security through Nasdaq.

"Securities" are any agreement for investment. Stocks are the securities most often addressed in described embodiments of the invention. The invention, however, is applicable to many kinds of securities including, for example, options, commodities, and bonds.

"Side" refers to which side of the market is represented by an order or a quote. Side indicates whether the quote or order is to buy or sell, bid or ask. "Bid" indicates the buy side. "Ask" indicates the sell side. The present invention functions equally for either

side of a transaction. Therefore we attempt to speak in neutral terms regarding side. We speak of execution rather than buying or selling. We use the term "price improvement" to indicate both price reductions for buy orders and price increases for sell orders.

Detailed Description:

Figure 1 shows an overview of a first aspect of the invention, a method (102) of load balancing data communications ports in systems for automated trading of securities. In the first illustrated embodiment, the systems include at least one broker-dealer system (106) coupled for data communications (140) through at least one data communications system (104) to more than one market (130-134). The illustrated embodiment of the data communications system is coupled to a multiplicity of data communications ports (110-126) organized so that one market (130) is coupled to the broker-dealer system through more than one port (110,112). The method (102) is applied when a new order (108) from the broker-dealer system (106) is available and ready to be sent through a port to a market. In typical embodiments, the method is applied continually in turn to each of the ports assigned to a market.

Figure 2 is a more specific illustration of certain embodiments of the invention. One embodiment shown in Figure 2 includes receiving (202) through a port (218) from a market (222) to which the port is coupled (252) a new acknowledgment (204) of an order (230) previously sent through the port from the broker-dealer system to the market. This embodiment includes sending (206) the new acknowledgment (204) to the broker-dealer system (106) where the new acknowledgment is stored in computer memory (226) with other acknowledgment (224). The illustrated embodiment includes determining (208) that the port is not overloaded, the determination being dependent upon the previously-sent order (230), the new acknowledgment (204), and optionally also dependent upon other previous orders (228) and upon previous acknowledgments (224). The illustrated

embodiment also includes sending (210) a new order (212) through the port to the market. Sending (210) the new order is dependent upon the determination (208) that the port is not overloaded. That is, in this embodiment, new orders are sent to markets only through ports that are not overloaded.

In a further embodiment shown in Figure 3, determining (208) that the port is not overloaded further comprises determining (326) that a latency (320, 322) for the port is less than a maximum allowed latency (324) for the port. Latency comprises a measure of the speed with which markets return acknowledgments for orders.

As shown in Figure 3, in one embodiment, the latency for the port is an instant latency (320). In an alternative embodiment, the latency for the port is an average latency (322). In embodiments using latencies as shown in Figure 3, the port latencies are dependent upon orders (310) and acknowledgments (312) in that the latencies comprise various kinds of comparisons between order times (314), the times when particular order were sent to a market, and acknowledgment times (316), the times when acknowledgments corresponding to particular orders were received back from markets.

More specifically, an instant latency (320) is the difference between the time when a recent acknowledgment was received and the time when the acknowledgment's corresponding order was sent. In addition, as shown in Figure 5, an average latency in some embodiments is a decaying average (524) and in other embodiments is a moving average (522). Examples of methods and systems useful with the present invention for calculating latencies are set forth in Appendix I. The use of any method of calculating latency is well within the present invention.

A further embodiment shown in Figure 4 includes decrementing (402) a net order count (504) for the port (218), wherein the net order count (504) indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been

received from the market. The net order count (504) for the port (218) is stored in computer memory in a port data structure (502).

An example of a port data structure useful in many embodiments of the invention is shown in Figure 5. The term "port data structure" means a data structure for storing data descriptive of the port. It does not mean that the port data structure is part of the port. On the contrary, in most embodiment, port data structures are stored in computer memory in a communications system in which a method of load balancing method is implemented according to the present invention.

The further embodiment illustrated in Figure 4 includes determining (404) that the net order count (504) is less than a maximum allowed net order count (506) for the port. The maximum net order count (506) indicates the maximum number of orders without acknowledgments allowed to be sent through the port (218). The fact that the net order count (504) is less than the maximum net order count (506) for the port (218) indicates that the port (218) is not overloaded.

This further embodiment shown in Figure 4 includes incrementing (406) the net order count. Alternative embodiments increment (406) the net order count (504) after determining (404) that the net order count (504) is less than the maximum net order count (506) for the port but before (408) sending (210) a new order (212) to market (222). Other embodiments increment (406) the net order count (504) after determining (404) that the net order count (504) is less than the maximum net order count (506) for the port (218) and also after (410) sending (210) a new order (212) to market (222).

A further embodiment shown in Figure 6 includes incrementing (602) an acknowledgment count (510) for the port (218). The acknowledgment count (510) represents the number of acknowledgments received through the port (218) during a defined period of time. An example of a period of time useful with various embodiments

of the invention is one trading day. Other embodiments use other time periods, some shorter, some longer. Any functional time period is within the scope of the invention.

A further embodiment shown in Figure 6 includes determining (604) that an order count (508) for the port (218) exceeds the acknowledgment count (510) for the port (218) by at least a maximum net order count (506). The order count (508) represents the number of orders sent through the port (218) during the defined period of time. The maximum net order count (506) indicates the maximum number of orders for which acknowledgments have not been received allowed to be sent through the port. The fact that the order count (508) for the port (218) exceeds the acknowledgment count (510) by at least the value of the maximum net order count (506) indicates that the port (218) is not overloaded.

This illustrated embodiment of Figure 6 includes incrementing (606) the order count for the port. Alternative embodiments increment (606) the order count (508) after determining (604) that the order count (508) for the port (218) exceeds the acknowledgment count (510) by at least the value of the maximum net order count (506) but before (608) sending (210) a new order (212) to market (222). Other embodiments increment (606) the order count (508) after determining (604) that the order count (508) for the port (218) exceeds the acknowledgment count (510) by at least the value of the maximum net order count (506) and also after (610) sending (210) a new order (212) to market (222).

A further embodiment of the invention as shown in Figure 7 includes determining (740), before sending (206) the new order (212) through the port (216) to the market (222), that the port is a least-loaded port. In this kind of embodiment, sending (206) the new order (212) through the port to the market is dependent (750) upon determining that the port is a least-loaded port (740).

More specifically, in this kind of embodiment, shown in Figure 7, utilizing detection of

least-loaded ports for load balancing, new orders typically are sent only through ports determined to be least-loaded. "Least-loaded" means generally that according to some measure of data communications load, the load of the subject port is at least as low as any other port. That is, although there may be other ports for the market having the same load as the subject port, there is no port with a lower load. Measures of data communications load useful with the invention include, for example, measure of latency and net order count.

In a specific embodiment shown in Figure 7, determining that the port is a least-loaded port (740) further comprises determining (742) that the net order count (710) for the port (216) is not greater than any of the net order counts (720, 730) for the other ports (218, 220) coupled to the market (222). In this illustrated embodiment, determining (742) that the net order count (710) for the port (216) is not greater than any of the net order counts (720, 730) for the other ports (218, 220) coupled to the market (222) is the indication that the port (216) is a least-loaded port. As shown in Figure 7, the embodiment provides data structures (702, 704, 706) for computer memory in which are stored the net order counts (710, 720, 730), one data structure (702, 704, 706) corresponding (703, 705, 707) to each port (216, 218, 220). The net order counts (710, 720, 730) indicate the net number of orders sent through the ports (216, 218, 220) to the market (222) for which acknowledgments have not yet been received from the market.

An alternative embodiment shown also in Figure 7 determines (740) the port (216) to be least-loaded by determining (744) that a latency (712) for the port is not greater than any of the latencies (722, 732) for the other ports (218, 220) coupled to the same market (222). In this illustrated embodiment, the latencies (712, 722, 732) are stored in port data structures (702, 704, 706), one data structure for each port. Latency comprises a measure of the speed with which markets return acknowledgments for orders.

Each port, in the illustrated embodiment of Figure 7, is characterized by a measured or

calculated latency(712, 722, 732). The latencies in various embodiments are instant latencies, moving average latencies, decaying average latencies, or other forms of latency. Most forms of measurement or calculation of the speed or time delay required to send orders to a market through a port and receive in return corresponding acknowledgments are functional latencies within the scope of the present invention.

A further alternative embodiment shown in Figure 7 determines (740) that the port is a least-loaded port by determining (746) that the product of the net order count (710) for the port (216) multiplied by the latency (712) for the port (216) is not greater than the product of net order count (720, 730) and latency (722, 732) for any other port (218, 220) coupled to the market (222). In this illustrated embodiment, the latencies (712, 722, 732) and the net order counts (710, 720, 730) are stored in port data structures (702, 704, 706), one data structure for each port.

Turning to Figure 8, an overview of a further aspect of the invention is seen. Figure 8 shows a load balancing system (802) for automated trading of securities in which data communications loads are balanced among data communications ports (816-832). The load balancing system (802) in one embodiment illustrated in Figure 8 is coupled to a multiplicity of ports (816-832) organized so that one market is coupled to the broker-dealer system through more than one port, the markets identified in Figure 8 by reference numbers 834-838. In the embodiment illustrated, the load balancing system (832) is programmed to operate when a new order (814) from a broker-dealer system (810) is available and ready to be sent through a port (816-832) to a market (834-838). The load balancing system of the kind illustrated in Figure 8 is programmed to operate continually in turn upon each of the ports assigned to a market.

Turning now to Figure 9, more specific embodiments of a load balancing system (902) are shown. In one of the embodiments shown in Figure 9, the load balancing system (902) includes at least one computer processor (904) coupled (972) for data

communications to at least one broker-dealer system (908). In this embodiment, the processor is coupled (962-970) through data communications ports (932-940) to a market (950). In the illustration of Figure 9, only one market and one group of associated ports are shown. In most embodiments, the processor is coupled to more than one market, and each market is coupled to at least one port, as shown on Figure 8.

In a further embodiment shown in Figure 9, the processor (904) is programmed to receive (920) through a port (936) from a market (950) to which the port is coupled (956) a new acknowledgment (916) of an order previously sent through the port (974, 910) from the broker-dealer system to the market. In this illustrated embodiment, the processor is programmed to send (922) the new acknowledgment (916) to the broker-dealer system (908). This embodiment includes the processor programmed to determine (930) that the port (936) is not overloaded. In the illustrated embodiment, the determination that the port is not overloaded is dependent upon the previously-sent order (910), the new acknowledgment (916), and optionally also dependent upon other previous orders (912) and upon previous acknowledgments (918).

The embodiment illustrated in Figure 9 also includes the processor programmed to send (928) a new order (914) through the port (936) to the market (950). The processor's sending (928) the new order (914) is dependent upon the determination (930) that the port is not overloaded. More specifically, in embodiments of the kind illustrated, orders are sent to markets over through non-overloaded ports.

The embodiment illustrated in Figure 9 includes computer memory (906) coupled (976) to the processor (904). In the illustrated embodiment, the processor (904) is further programmed to store (924) in the computer memory (906) the new acknowledgment (916) and the new order (914).

In a further embodiment shown in Figure 10, the processor (904) programmed to

determine that a port is not overloaded (930) further comprises the processor programmed to determine (1002) that a latency (1020, 1022) for a port (932) is less than a maximum allowed latency (1024) for the port. Latency comprises a measure of the speed with which markets return acknowledgments for orders. In one embodiment shown in Figure 10, the latency for the port is an instant latency (1020). In an alternative embodiment, the latency for the port is an average latency (1024).

In embodiments using latencies as shown in Figure 10, the port latencies are dependent upon order data (1010) and acknowledgment data (1014) in that the latencies comprise various kinds of comparisons between order times (1012) and acknowledgment times (1016). Order times are the times when particular order were sent to a market, and acknowledgment times (1016) are the times when acknowledgments corresponding to particular orders were received back from markets.

More specifically, an instant latency (1020) is the difference between the time when a recent acknowledgment was received and the time when the acknowledgment's corresponding order was sent. In addition, as shown in Figure 5, an average latency in some embodiments is a decaying average (524) and in other embodiments is a moving average (522). Examples of methods and systems useful with the present invention for calculating latencies are set forth in Appendix I. The use of any method of programming a processor to calculate latency is well within the present invention.

In the embodiment shown in Figure 10, the latency calculations (1018) are performed in a broker-dealer system (908) and provided (1026, 1028) to the load balancing system for storage in computer memory (906). In other embodiments, the processor in the load balancing system is programmed to calculate latencies. In the illustrated embodiment of Figure 10, the latencies are stored in memory in port data structures (1004-1008) with one data structure provided for each port (932-936) used with the system. An example of a useful port data structure is shown in Figure 5. Many alternative structures for port data

are useful within the scope of the invention.

A further embodiment of the invention as shown in Figure 11 includes the processor (906) programmed to decrement (1102) a net order count (504) for the port (932). The net order count (504) indicates the net number of orders sent through the port (932) to the market (950) for which acknowledgments have not yet been received from the market. In this embodiment, the net order count (504) is decremented (1102) after (1101) receiving (920) a new acknowledgment (916).

The embodiment shown in Figure 11 includes the processor (906) programmed to determine (1104) that the net order count (504) is less than a maximum allowed net order count (506) for the port (932). The maximum allowed net order count (506) indicates the maximum number of orders without acknowledgments allowed to be sent through the port (932). The fact that the net order count is less than the maximum allowed net order count for the port indicates that the port is not overloaded.

This embodiment illustrated in Figure 11 includes the processor programmed to increment (1106) the net order count. In some embodiments, the processor is programmed to increment (1106) the net order count after determining (1104) that the net order count is less than the maximum net order count but before (1108) sending a new order to market. In other embodiments, the processor is programmed to increment (1106) the net order count after determining (1104) that the net order count is less than the maximum net order count and after (1110) sending a new order to market.

A further embodiment of the invention shown in Figure 12 includes the processor (906) programmed to increment (1202) an acknowledgment count (510) for the port (932). The acknowledgment count (510) represents the number of acknowledgments received through the port during a defined period of time. An example of a period of time useful in the invention is one trading day. Various embodiments of the inventions use other

periods of time, shorter or longer. Any functional period of time is well within the scope of the invention.

A further embodiment of the invention shown on Figure 12 includes the processor (906) programmed to determine (1206) that an order count (508) for the port (932) exceeds the acknowledgment count (510) for the port (932) by at least a maximum allowed net order count (506). The order count (508) represents the number of orders sent through the port (932) during the defined period of time. The maximum net order count (506) indicates the maximum number of orders without acknowledgments allowed to be sent through the port (932). In this embodiment, the fact that the order count (508) for the port exceeds the acknowledgment count (510) for the port (932) by at least a maximum allowed net order count (506) indicates that the port is not overloaded.

The embodiment shown in Figure 12 includes also the processor programmed to increment (1204) the order count (508) for the port (932). In some embodiments, the processor is programmed to increment (1204) the order count (508) for the port (932) after determining (1206) that the order count (508) for the port (932) exceeds the acknowledgment count (510) for the port (932) by at least a maximum allowed net order count (506) but before (1208) sending (928) a new order to market. In other embodiments, the processor is programmed to increment (1204) the order count (508) for the port (932) after determining (1206) that an order count (508) for the port (932) exceeds the acknowledgment count (510) for the port (932) by at least a maximum allowed net order count (506) and after (1210) sending (928) a new order (914) through the port (932) to market (950).

A further embodiment shown on Figure 13 includes the processor (904) programmed to determine (1340), before sending (928) the new order through the port (932) to the market (950), that the port (932) is a least-loaded port. In this embodiment, the processor's sending (928) the order through the port to the market is dependent upon the

determination (1340) that the port is a least-loaded port. More specifically, in this kind of embodiment, orders are sent to markets only through least-loaded ports.

A further embodiment of the invention illustrated in Figure 13 includes a data structure (1302) for the port (932) having a net order count (1310) for the port (932). The net order count (1310) indicates the net number of orders sent through the port (932) to the market (950) for which acknowledgments have not yet been received from the market. In the illustrated embodiment, other ports (936, 940) coupled to the market (950) have data structures (1304, 1306) having net order counts (1320, 1330). In the illustrated embodiment, the processor (904) programmed to determine (1340) that the port is a least-loaded port further comprises the processor programmed to determine (1342) that the net order count (1310) for the port is not greater than any of the net order counts (1320, 1330) for the other ports coupled to the market (950).

A further embodiment of the invention illustrated in Figure 13 includes a port data structure (1302) in which the port data structure has a latency (1312) for the port (932). Latency comprises a measure of the speed with which markets return acknowledgments for orders. In this embodiment, other ports (936, 940) coupled to the market (950) have data structures (1304, 1306) having latencies (1322, 1332). In the illustrated embodiment, the processor (904) programmed to determine (1340) that the port is a least-loaded port comprises the processor (904) programmed to determine (1344) that the latency (1312) for the port (932) is not greater than any of the latencies (1322, 1332) for the other ports (1304, 1306) coupled to the market (950).

A further embodiment of the invention illustrated in Figure 13 includes a port data structure (1302) having a net order count (1310) for the port (932) and a latency (1312) for the port (932). The net order count (1310) indicates the net number of orders sent through the port (932) to the market (950) for which acknowledgments have not yet been received from the market. Latency comprises a measure of the speed with which markets

return acknowledgments for orders. In the illustrated embodiment, other ports (936, 940) coupled to the market (950) also have corresponding data structures (1304, 1306) having net order counts (1320, 1330) and latencies (1322, 1332). In the illustrated embodiment, the processor (904) programmed to determine (1340) that the port is a least-loaded port further comprises the processor programmed (1346) to determine that the product of the net order count (1310) for the port (932) multiplied by the latency (1312) for the port (932) is not greater than the product of net order count (1320, 1330) and latency (1322, 1332) for any other port (936, 940) coupled to the market (950).

CLAIMS

What is claimed is:

1. A method of balancing data communications loads among data communications ports in systems for automated trading of securities, the systems including at least one broker-dealer system coupled through at least one data communications system to more than one market system, the data communications system including a multiplicity of ports organized so that one market is coupled to the broker-dealer system through more than one port, the method operating as an adjunct to a broker-dealer system, the method applied when a new order from the broker-dealer system is available and ready to be sent through a port to a market; the method being applied continually in turn to each of the ports assigned to a market, the method comprising the steps of:

    receiving through a port from a market to which the port is coupled a new acknowledgment of an order previously sent through the port from the broker-dealer system to the market;

    sending the new acknowledgment to the broker-dealer system;

    determining that the port is not overloaded, the determination being dependent upon the previously-sent order, the new acknowledgment, and optionally also dependent upon other previous orders and upon previous acknowledgments; and

    sending a new order through the port to the market, the sending of the new order being dependent upon the determination that the port is not overloaded.

2. The method of claim 1 wherein determining that the port is not overloaded comprises determining that a latency for the port is less than a maximum allowed latency for the port, wherein latency comprises a measure of the speed with which markets return

acknowledgments for orders.

3. The method of claim 1 further comprising decrementing a net order count for the port, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, wherein the net order count is decremented after receiving a new acknowledgment.

4. The method of claim 3 further comprising the steps of:

determining that the net order count is less than a maximum allowed net order count for the port, wherein the maximum allowed net order count indicates the maximum number of orders without acknowledgments allowed to be sent through the port, wherein the net order count less than the maximum allowed net order count for the port indicates that the port is not overloaded; and

incrementing the net order count.

5. The method of claim 1 further comprising incrementing an acknowledgment count for the port, wherein the acknowledgment count represents the number of acknowledgments received through the port during a defined period of time.

6. The method of claim 5 further comprising the steps of:

determining that an order count for the port exceeds the acknowledgment count for the port by at least a maximum allowed net order count, wherein the order count represents the number of orders sent through the port during the defined period of time, wherein the maximum allowed net order count indicates the maximum number of orders without acknowledgments allowed to be sent

through the port, wherein the order count for the port exceeding the acknowledgment count for the port by at least a maximum allowed net order count indicates that the port is not overloaded; and

incrementing the order count for the port.

7. The method of claim 1 further comprising determining, before sending the new order through the port to the market, that the port is a least-loaded port, wherein sending the order through the port to the market is dependent upon determining that the port is a least-loaded port.

8. The method of claim 7 wherein the port comprises a net order count, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, and other ports coupled to the market have net order counts, wherein determining that the port is a least-loaded port comprises determining that the net order count for the port is not greater than any of the net order counts for the other ports coupled to the market.

9. The method of claim 7 wherein the port comprises latency, wherein latency comprises a measure of the speed with which markets return acknowledgments for orders, wherein the other ports coupled to the market have latencies, wherein determining that the port is a least-loaded port comprises determining that the latency for the port is not greater than any of the latencies for the other ports coupled to the market.

10. The method of claim 7 wherein the port comprises a net order count and a latency, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, wherein latency comprises a measure of the speed with which markets return

acknowledgments for orders, wherein the other ports coupled to the market have net order counts and latencies, wherein determining that the port is a least-loaded port comprises determining that the product of the net order count for the port multiplied by the latency for the port is not greater than the product of net order count and latency for any other port coupled to the market.

11. A load balancing system for automated trading of securities in which data communications loads are balanced among data communications ports, the load balancing system coupled to a multiplicity of ports organized so that one market is coupled to the broker-dealer system through more than one port, the load balancing system operative when a new order from a broker-dealer system is available and ready to be sent through a port to a market, the load balancing system operative continually in turn upon each of the ports assigned to a market, the load balancing system comprising:

at least one computer processor coupled for data communications to at least one broker-dealer system and coupled through data communications ports to more than one market, the processor programmed to:

receive through a port from a market to which the port is coupled a new acknowledgment of an order previously sent through the port from the broker-dealer system to the market;

send the new acknowledgment to the broker-dealer system;

determine that the port is not overloaded, the determination being dependent upon the previously-sent order, the new acknowledgment, and optionally also dependent upon other previous orders and upon previous acknowledgments; and

send a new order through the port to the market, the sending of the new order being dependent upon the determination that the port is not overloaded; and

computer memory coupled to the processor, the processor further programmed to store in the computer memory the new acknowledgment and the new order.

12. The load balancing system of claim 11 wherein the processor programmed to determine that the port is not overloaded comprises the processor programmed to determine that a latency for the port is less than a maximum allowed latency for the port, wherein latency comprises a measure of the speed with which markets return acknowledgments for orders.

13. The load balancing system of claim 11 further comprising the processor programmed to decrement a net order count for the port, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, wherein the net order count is decremented after receiving a new acknowledgment.

14. The load balancing system of claim 13 further comprising the processor programmed to:

determine that the net order count is less than a maximum allowed net order count for the port, wherein the maximum allowed net order count indicates the maximum number of orders without acknowledgments allowed to be sent through the port, wherein the net order count less than the maximum allowed net order count for the port indicates that the port is not overloaded; and

increment the net order count.

15. The load balancing system of claim 11 further comprising the processor programmed to increment an acknowledgment count for the port, wherein the acknowledgment

count represents the number of acknowledgments received through the port during a defined period of time.

16. The load balancing system of claim 15 further comprising the processor programmed to:

determine that an order count for the port exceeds the acknowledgment count for the port by at least a maximum allowed net order count, wherein the order count represents the number of orders sent through the port during the defined period of time, wherein the maximum allowed net order count indicates the maximum number of orders without acknowledgments allowed to be sent through the port, wherein the order count for the port exceeding the acknowledgment count for the port by at least a maximum allowed net order count indicates that the port is not overloaded; and

increment the order count for the port.

17. The load balancing system of claim 11 further comprising the processor programmed to determine, before sending the new order through the port to the market, that the port is a least-loaded port, wherein sending the order through the port to the market is dependent upon the determination that the port is a least-loaded port.

18. The load balancing system of claim 17 wherein a data structure for the port comprises a net order count for the port, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, and other ports coupled to the market have data structures having net order counts, wherein the processor programmed to determine that the port is a least-loaded port comprises the processor programmed to determine that the net order count for the port is not greater than any of the net order counts for

the other ports coupled to the market.

19. The load balancing system of claim 17 wherein a data structure for the port comprises latency, wherein latency comprises a measure of the speed with which markets return acknowledgments for orders, wherein the other ports coupled to the market have data structures having latencies, wherein the processor programmed to determine that the port is a least-loaded port comprises the processor programmed to determine that the latency for the port is not greater than any of the latencies for the other ports coupled to the market.

20. The load balancing system of claim 17 wherein a data structure for the port comprises a net order count and a latency, wherein the net order count indicates the net number of orders sent through the port to the market for which acknowledgments have not yet been received from the market, wherein latency comprises a measure of the speed with which markets return acknowledgments for orders, wherein the other ports coupled to the market have data structures having net order counts and latencies, wherein the processor programmed to determine that the port is a least-loaded port comprises the processor programmed to determine that the product of the net order count for the port multiplied by the latency for the port is not greater than the product of net order count and latency for any other port coupled to the market.

ABSTRACT

Methods and systems for balancing data communications loads among data communications ports in systems for automated trading of securities. Embodiments typically include receiving acknowledgments of orders previously sent through a port from a broker-dealer system to a market, sending acknowledgments to the broker-dealer system, and determining that port are not overloaded. Various embodiments make determinations of overload on the basis of latency, net order count, or order count compared with acknowledgment count. Alternative embodiments send orders only through least-loaded ports. Least-loaded ports are identified on the basis of latency, net order count, or a combination of the two.

APPENDIX I

Specification And Figures to: U.S. Patent Application Serial No. 09/574,595 entitled "Latency Monitor," inventor Michael Bundy, Attorney Docket Number 30418US, filed May 19, 2000, 21 pages of Specification and Figure 1A through Figure 9, attached hereto and *incorporated herein by reference.*

BACKGROUND

Broker-dealers increasingly make available to their customers on-line submission, cancellation, and tracking of the status of orders for securities. Securities trading customers include day traders, institutions, and active private investors. Such customers make many quick decisions regarding when and from whom to order securities. Customers are increasingly demanding regarding quality and speed of execution. Customers require a high quality of information to support their decision-making. Customers are often presented with quotes identifying markets from which particular securities can be bought or sold at particular prices. In such quotes there are often several markets quoting securities at the current inside price. Markets quoting the same price, however, are not the same in terms of quality of execution. Especially regarding speed, all markets are different. It would be useful, therefore, if customers had a display of information helpful in identifying which markets are likely to execute orders more quickly than others.

Modern broker-dealers often subscribe to one or more exchanges or ECNs ("markets") capable of executing orders for securities by matching orders with orders of opposite side. Orders, cancellations, and responses are communicated to and from markets by use of data communications ports. Many broker-dealers handle volumes of orders so large as to require more than one port per market. Ports often are not equal in their ability to communicate with a particular market. Sometimes ports fail, partially or completely. It would be useful to have a display of information, for diagnostic purposes within the broker-dealer organizations, to help identify problems with particular ports, to help keep the overall flow of data communications functioning efficiently.

SUMMARY

One aspect of the invention provides methods for displaying latency. Embodiments of the invention are typically implemented in broker-dealer computer systems engaged generally in automated processing of orders for securities including sending to markets messages comprising orders and cancellations and receiving from markets responses to orders and cancellations. Embodiments include recording for messages sent to markets the time when each message is sent and the identity of the market to which each message is sent. Embodiments include recording for responses received from markets the time when each response is received, wherein each response corresponds to a particular message. Embodiments include calculating latencies for markets dependent upon recorded time when a message is sent to the market and a recorded time when a corresponding response is received from the market. Embodiments include latencies for ports as well as latencies for markets. Embodiments include displaying the identity of the markets and the latencies for the markets. Embodiments include counting and displaying the number of messages and responses received and sent during a period of time, for use in broker-dealer diagnostics.

A second aspect of the invention provides automated computing machinery, as system for calculating and displaying latency, typically implemented in broker-dealer computer systems capable of automated processing of orders for securities, includes sending messages to markets and receiving from markets responses to messages. Embodiments of this aspect include at least one computer processor programmed to record in computer memory, for messages sent to markets, the time when each message is sent and the identity of the market to which each message is sent. In such embodiments, processors are typically programmed also to record in computer memory, for responses received from markets, the time when each response is received. Each response corresponds to a particular message. In such embodiments, processors are programmed also to calculate for markets latencies dependent upon recorded time when at least one message is sent to a market and recorded time when a corresponding response is received from the market. In such embodiments, processors typically are programmed also to display the identities

of the markets and the latencies for the markets. Embodiments include latencies for ports as well as latencies for markets. Embodiments of this aspect typically include computer memory coupled to processors, the processors being further programmed to store in computer memory the latencies. Embodiments include processors programmed to count and display the number of messages and responses received and sent during a period of time, for use in broker-dealer diagnostics.

DRAWINGS

Figure 1A is a general data flow diagram showing various alternative embodiments of the invention.

Figure 1B is a detail of relations among ports and markets in various alternative embodiments of the invention.

Figure 2 illustrates calculating instant latency.

Figure 3 illustrates an alternative embodiment using average latency.

Figure 4 illustrates another alternative embodiment using average latency.

Figure 5A illustrates a form of display.

Figure 5B illustrates an alternative form of display.

Figure 5C illustrates an alternative form of display.

Figure 6 illustrates computing machinery for various alternative embodiments of the invention.

Figure 7 illustrates computing machinery programmed to calculate instant latency.

Figure 8 illustrates computing machinery programmed to count and display the number of messages and responses received and sent during a period of time.

Figure 9 illustrates computing machinery programmed to count and display the number of messages and responses received and sent through a port during a period of time.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

Definitions:

"Cancellation" is termination of an order, or partial termination of an order, by the

customer or by software comprising an embodiment of the invention. In addition, markets can cancel orders, or parts of orders, for example, in response to an IOC order.

"ECN" abbreviates "Electronic Communications Network," referring to an order matching service that provides liquidity by matching orders rather than by maintaining inventory. In the context of the invention, ECNs are considered markets. ECNs, like market makers are identified by use of market participant identification codes or "MPIDs." In order to avoid confusion with data communications networks, ECNs are referred to as either "ECNs" or as "markets." Some current ECNs, their symbols and names, are listed below. The number and identities of ECNs changes from time to time.

Example List of ECNs	
MPID	**Name**
ARCA	Archipelago
BTRD	Bloomberg Trade Book
INCA	Instinet
ISLD	Island
MWSE	Midwest Stock Exchange
NTRD	NexTrade
REDI	Speer Leeds

"Exchange" means a national, regional, or international exchange for securities trading including for example, Nasdaq or NYSE.

"Executed," in reference to an order, means that shares have been either bought or sold according to the side of the order.

"Filled" means executed. That is, all shares in the order have been executed, bought or sold according to the side of the order. If an order is subject to partial fulfillment, then the order can be partly filled and partly rejected or cancelled, in which case the order will never be considered filled. Processing of an order can therefore be completed through

some combination of cancellation, rejection, killing, and partial execution without the order's ever being filled. Processing of an order is said to be complete when all the shares in the order, share by share, have been executed, cancelled, rejected, or killed.

"Inside price" means, as appropriate, the highest bid price or the lowest ask price for a particular security. For buy orders, the inside price is the lowest ask price. For sell orders, the inside price is the highest bid price.

"Latency" means a measure of the speed with which markets respond to orders and cancellations. Latency in many embodiments of the invention is determined as the difference between the time when a response to an order is received and the time when the corresponding order was routed to the market. Latency can be measured from normal orders or from test orders. Some markets support test orders as such. For markets in which test orders as such are not supported, test orders can be implemented by use of unmarketable orders immediately followed by cancellations. For markets receiving orders regularly, latency can be tracked from normal orders, without the need for test orders. Latency can be embodied as a single ratio difference between two recorded times or as various kinds of averages.

"Level Two Quotes" are quotes that comprise one or more market participant quotes ("MPQs"). The best known source of level two quotes is Nasdaq, but "level two quotes" refers to any form of market information that aggregates market participant quotes for a security.

"Market," "electronic market," "market participant," "electronic market participant," "marketing network," and electronic marketing network" are all used as synonyms for services accessible through electronic communications networks capable of executing orders for securities by accepting from broker-dealers buy orders and sell orders, matching or failing to match buy orders with sell orders, and communicating the results to the broker-dealers. Generally the term "market" is used to refer to these entities. All "markets," as the term is used, are either ECNs or market makers. All available markets

have names and symbols as described under the definitions of "ECN" and "market maker."

"Market maker" means a broker-dealer providing order matching and liquidity in a stock by maintaining an inventory of the stock. Market makers typically trade their inventories through exchanges. Some currently active market makers, their symbols and names, are listed below. The number and identity of market makers can change from time to time.

Example List of Market Makers	
MPID	**Name**
BEST	Bear, Stearns & Co., Inc.
BTAB	Alex, Brown & Sons, Inc.
GSCO	Goldman, Sachs & Co.
HMQT	Hambrecht & Quist, LLC
HRZG	Herzog, Heine, Geduld, Inc.
JANY	Janney Montgomery Scott, Inc.
LEHM	Lehman Brothers, Inc.
MADF	Bernard L. Madoff
MLCO	Merrill Lynch, Pierce, Fenner & Smith Inc.
MOKE	Morgan, Keehan & Co., Inc.
MONT	Nationsbanc Montgomery Securities, LLC
MSCO	Morgan Stanley & Co., Inc.
NITE	Knight Securities, L.P.
OLDE	Olde Discount Corporation
OPCO	CIBC Oppenheimer Corporation
PIPR	Piper Jaffray Inc.
PRUS	Prudential Securities, Inc.
PWJC	Paine Webber, Inc.

RAJA	Raymond James & Associates, Inc.
SBSH	Smith Barney, Inc.
SHRP	Sharpe Capital, Inc.
SHWD	Sherwood Securities Corporation

"Orders" are orders for purchase or sale of securities. In many of the embodiments described, "orders" are electronic orders for purchase or sale of securities.

"Quotes" are aggregates of information regarding securities traded in markets. Quotes include for securities listed for sale or purchase, symbols identifying the securities, price, side, quantities, and market identifications or MPIDs. Quotes can come from exchanges or directly from markets. A "Nasdaq Level Two Quote" includes market information in the form of market participant quotes for all markets offering to buy or sell a particular security through Nasdaq.

"Securities" are any agreement for investment. Stocks are the securities most often addressed in described embodiments of the invention. The invention, however, is applicable to many kinds of securities including, for example, options, commodities, and bonds.

"Side" refers to which side of the market is represented by an order or a quote. Side indicates whether the quote or order is to buy or sell, bid or ask. "Bid" indicates the buy side. "Ask" indicates the sell side. The present invention functions equally for either side of a transaction. Therefore we attempt to speak in neutral terms regarding side. We speak of execution rather than buying or selling. We use the term "price improvement" to indicate both price reductions for buy orders and price increases for sell orders.

Detailed Description:

Turning now to Figure 1A, a first aspect of the invention is seen. One embodiment illustrated in Figure 1A provides a method of displaying latency. The embodiment is

implemented in a broker-dealer computer system. The system is engaged in automated processing of orders (150) for securities including sending (104) messages (102) to markets (108) and receiving (112) from markets (108) responses (114) to messages.

The illustrated embodiment includes recording (106) for messages sent to markets the time (120) when each message is sent and the identity (118) of the market to which each message is sent, the messages (102) comprising orders (150) and cancellations (148) of orders. This first embodiment includes also recording (110) for responses received from markets the time (122) when each response is received, wherein each response corresponds to a particular message.

This embodiment includes also calculating (124) for at least one market a latency (128) dependent upon at least one recorded time (120) when at least one message is sent to the market and at least one recorded time (122) when a corresponding response is received from the market. The illustrated embodiment includes displaying (130) the identity (118) of the market and the latency (128) for the market. In a further embodiment shown in Figure 1A, latency (128) is a latency for a port (154), the port being identified by Port ID code (156).

Shown in Figure 5A is an example of a form of display useful with many embodiments of the invention. The example in Figure 5A illustrates a columnar display of identities (118) of markets and latency implemented as an instant latency (502) for each market and an average latency (504) for each market.

As shown on Figure 1A, the display function (130) in many embodiments sends (133) the display (135) to display devices (134) by use of data communications (132). Data communications (132) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data

communications is well within the invention.

In a further embodiment, shown in Figure 2, latency is implemented as an instant latency (202). The instant latency (202) is calculated (204) dependent upon one recorded time (120) when one message is sent to a market and one recorded time (122) when a corresponding response is received from the market.

In a still further embodiment, shown in Figure 3, latency is implemented as an average latency (320). The average latency (320) is dependent upon at least one recorded time (306, 314) when at least one message is sent to the market and at least one recorded time (308, 316) when a corresponding response is received from the market. In embodiments of the kind shown in Figure 3, the recorded times (306, 308, 314, 316) used in calculating the average latency (320) are recorded during a defined period of time (322).

In a further embodiment, shown in Figure 4, the latency is implemented as an average latency (420). The average latency is dependent upon at least one recorded time (408, 414) when at least one message is sent to the market and at least one recorded time (410, 416) when a corresponding response is received from the market. In embodiments shown in Figure 4, the number of recorded times (408, 410, 414, 416) used to calculate the average latency (420) is limited to a defined maximum number "N" (422). In many embodiments of this kind, the N recorded times used to calculate average latency are the N most recent recorded times.

A further embodiment shown in Figure 1A includes the steps of counting (136) the number of messages sent to at least one market during a period of time, including storing in computer memory (140) the number of messages (144) sent to the market during the period of time. In many embodiments of this kind, the counting steps (138, 136) determine time periods in dependence upon a computer system clock (170).

The illustrated embodiment includes also counting (138) the number of responses

received from the market during the period of time, including storing in computer memory (140) the number of responses (146) received from the market during the period of time. The embodiment includes also displaying (130), in addition to the identity (118) of the market and the latency (128) for the market, the number of messages (144) sent to the market and the number of responses (146) received from the market during the period of time.

Figure 5C shows an example of a display useful with various embodiments using such displays display in columnar form the market identities (118), latencies (320), number of messages sent during a period of time (144), and the number of responses received during a period of time (146). As shown on Figure 1A, the display function (130) in many embodiments sends (133) the display (135) to display devices (134) by use of data communications (132). Data communications (132) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data communications is well within the invention.

An example of the use of message counts for diagnostic purposes is a display showing an increase in latency for a port explained by an increase in message counts for the port, thus indicating the port slowed down because its work load increased, and indicating also that there is no problem with the system. Another example is a display showing an increase in latency for a port explained by the port's message count going to zero, thus indicating that the increase in latency is caused by a catastrophic failure of the port.

In a further embodiment, shown in Figure 1A, the system includes the steps of counting (136) the number of messages sent to a market through a port (154) during a period of time, including storing in computer memory (140) the number of messages (144) sent to the market through the port during the period of time. In many embodiments of this kind, the counting steps (138, 136) determine time periods in dependence upon a computer system clock (170).

The illustrated embodiment includes also counting (138) the number of responses received from the market through the port during the period of time, including storing in computer memory (140) the number of responses (146) received from the market through the port during the period of time. The system includes also displaying (130), in addition to the identity (118) of the market and the latency (128) for the market, the number of messages (144) sent to the market through the port and the number of responses (146) received from the market through the port during the period of time.

Figure 5B shows an example of a display useful with various embodiments of the invention. Embodiments using such displays display in columnar form the market identities (118), port identity codes (154), instant latencies (202), average latencies (320), number of messages sent during a period of time (144), and the number of responses received during a period of time (146).

As shown on Figure 1A, the display function (130) in many embodiments sends (133) the display (135) to display devices (134) by use of data communications (132). Data communications (132) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data communications is well within the invention.

Turning now to Figure 6, an additional aspect of the invention is seen. One embodiment shown in Figure 6 is automated computing machinery implementing a broker-dealer computer system (602). The illustrated embodiment is capable of automated processing of orders for securities, including sending (606) messages (604) to markets (608) and receiving (610) from markets (608) responses (612) to messages.

The illustrated embodiment includes at least one computer processor (618) programmed to record (622) in computer memory (620), for messages sent to markets, the time (632)

when each message is sent and the identity (630) of the market (608) to which each message is sent, the messages including orders (614) and cancellations (616) of orders. In this embodiment, the processor is programmed also to record (624), in computer memory (620), for responses (612) received (610) from markets, the time (634) when each response is received. Each response (612) corresponds (642) to a particular message (604).

In this example embodiment, the processor is programmed also to calculate (626), for at least one market (608) a latency (628) dependent upon at least one recorded time (632) when at least one message is sent to the market and at least one recorded time (634) when a corresponding response is received from the market. In this embodiment, the processor is programmed also to display (632) of the identity (630) of the market and the latency (628) for the market. In a further embodiment shown in Figure 6, latency (628) for a market (608) is also latency for a port (644), the port being identified in data by a port ID code (646).

As shown on Figure 6, the display function (632) in many embodiments sends (633) the display (635) to display devices (638) by use of data communications (636). Data communications (636) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data communications is well within the invention. The embodiment illustrated in Figure 6 includes also computer memory (620) coupled (640) to the processor (618), the processor being further programmed to store (630) in computer memory (620) the latency (628).

In a further embodiment shown in Figure 7, latency comprises an instant latency. In the embodiment of Figure 7, the processor (618) is programmed to calculate (626) latency as an instant latency (702) calculated dependent upon one recorded time (632) when one message is sent to a market and one recorded time (634) when a corresponding response is received from the market.

In some embodiments, the processor is programmed to calculate latency as an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market. In such embodiments, as illustrated in Figure 3, recorded times (306, 308, 314, 316) used in calculating the average latency (320) are recorded during a defined period of time (322).

In other embodiments, the processor is programmed to calculate latency as an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market. In such embodiments, as shown in Figure 4, the number of the recorded times (408, 410, 414, 416) used to calculated the average latency is limited to a defined maximum number "N" (422). In many embodiments of this kind, the N recorded times used to calculate average latency are the N most recent recorded times.

In a further embodiment shown in Figure 8, latency comprises an average latency. In embodiments of the kind shown in Figure 8, the processor (618) is further programmed to count (802) the number (806) of messages (604) sent (606) to at least one market (608) during a period of time, including storing in computer memory (620) the number of messages (806) sent to the market during the period of time. Periods of time in many embodiments are determined dependent upon a system clock (816).

The processor in many embodiments of the kind illustrated in Figure 8, is also programmed to count (804) the number (808) of responses (612) received (610) from the market (608) during the period of time, including storing in computer memory (620) the number of responses (808) received from the market during the period of time. The system includes also displaying (814), in addition to the identity of the market and the

latency for the market, the number of messages (806) sent to the market and the number of responses (808) received from the market during the period of time.

Figure 5C shows an example of a display useful with various embodiments of the invention. Embodiments using such displays display in columnar form the market identities (118), latencies (320), number of messages sent during a period of time (144), and the number of responses received during a period of time (146). As shown on Figure 8, the display function (814) in many embodiments sends (815) the display (817) to display devices (638) by use of data communications (636). Data communications (636) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data communications is well within the invention.

In a further embodiment shown in Figure 9, the processor (618) is programmed to count (904) the number of messages (604) sent to a market (608) through a port (902) during a period of time, including storing (914) in computer memory (620) the number of messages (912) sent to the market (608) through the port (902) during the period of time. Periods of time in such embodiments typically are determined dependent upon a system clock (816).

The processor in many embodiments of the kind illustrated in Figure 9 is also programmed to count (906) the number of responses (612) received (610) from the market (608) through the port (902) during the period of time, including storing (916) in computer memory (620) the number of responses (910) received from the market (608) through the port (902) during the period of time. The embodiment as illustrated includes

also displaying (908), in addition to the identity (630 on Figure 6) of the market and the latency (628 on Figure 6) of the market, the number of messages (912) sent to the market (608) through the port (902) and the number of responses (910) received from the market (608) through the port (902) during the period of time.

Figure 5B shows an example of a display useful with various embodiments of the invention. Embodiments using such displays display in columnar form the market identities (118), port identity codes (154), instant latencies (202), average latencies (320), number of messages sent during a period of time (144), and the number of responses received during a period of time (146). As shown on Figure 9, the display function (908) in many embodiments sends (909) the display (911) to display devices (638) by use of data communications (636). Data communications (636) in some embodiments includes networks, such as intranets, extranets, or internets, and in other embodiments includes satellite channels, direct telephone links, and other forms of data communications. Use of any form of data communications is well within the invention.

CLAIMS

What is claimed is:

1. A method of displaying latency, the method implemented in a broker-dealer computer system, the system being engaged in automated processing of orders for securities including sending messages to markets and receiving from markets responses to messages, the method comprising the steps of:

recording for messages sent to markets the time when each message is sent and the identity of the market to which each message is sent, the messages comprising orders and cancellations of orders;

recording for responses received from markets the time when each response is received, wherein each response corresponds to a particular message;

calculating for at least one market a latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market;

displaying the identity of the market and the latency for the market.

2. The method of claim 1 wherein the latency for a market further comprises latency for a port.

3. The method of claim 1 wherein the latency comprises an instant latency calculated dependent upon one recorded time when one message is sent to a market and one recorded time when a corresponding response is received from the market.

4. The method of claim 1 wherein the latency comprises an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein all the recorded times used in calculating the latency are recorded during a defined period of time.

5. The method of claim 1 wherein the latency comprises an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein the number of recorded times used to calculated the average latency is limited to a defined maximum.

6. The method of claim 1 wherein the latency comprises an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein the calculating uses the latest recorded time when a message is sent to the market and the latest recorded time when a corresponding response is received from the market, and wherein the number of recorded times used to calculated the average latency is limited to a defined maximum.

7. The method of claim 1 further comprising the steps of:

counting the number of messages sent to at least one market during a period of time, including storing in computer memory the number of messages sent to the market during the period of time;

counting the number of responses received from the market during the period of time, including storing in computer memory the number of responses received from the market during the period of time; and

displaying, in addition to the identity of the market and the latency for the market, the number of messages sent to the market and the number of responses received from the market during the period of time.

8. The method of claim 1 further comprising the steps of:

counting the number of messages sent to a market through a port during a period of time, including storing in computer memory the number of messages sent to the market through the port during the period of time;

counting the number of responses received from the market through the port

during the period of time, including storing in computer memory the number of responses received from the market through the port during the period of time; and

displaying, in addition to the identity of the market and the latency for the market, the number of messages sent to the market through the port and the number of responses received from the market through the port during the period of time.

9. Automated computing machinery comprising a broker-dealer computer system, the system being engaged in automated processing of orders for securities including sending messages to markets and receiving from markets responses to messages, the machinery comprising:

at least one computer processor programmed to:

record in computer memory, for messages sent to markets, the time when each message is sent and the identity of the market to which each message is sent, the messages comprising orders and cancellations of orders;

record in computer memory, for responses received from markets, the time when each response is received, wherein each response corresponds to a particular message;

calculate, for at least one market, a latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market;

display the identity of the market and the latency for the market; and

computer memory coupled to the processor, the processor being further programmed to store in computer memory the latency.

10. The automated computing machinery of claim 9 wherein the latency for a market

further comprises latency for a port.

11. The automated computing machinery of claim 9 wherein the processor is further programmed to calculate latency as an instant latency calculated dependent upon one recorded time when one message is sent to a market and one recorded time when a corresponding response is received from the market.

12. The automated computing machinery of claim 9 wherein the processor is further programmed to calculate latency as an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein all the recorded times used in calculating the latency are recorded during a defined period of time.

13. The automated computing machinery of claim 9 wherein the processor is further programmed to calculate latency as an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein the number of recorded times used to calculated the average latency is limited to a defined maximum.

14. The automated computing machinery of claim 9 wherein the latency comprises an average latency dependent upon at least one recorded time when at least one message is sent to the market and at least one recorded time when a corresponding response is received from the market, wherein the processor is further programmed to calculate latency dependent upon the latest recorded time when a message is sent to the market and the latest recorded time when a corresponding response is received from the market, and wherein the processor is further programmed to use in calculating average latency a number of recorded times limited to a defined maximum.

15. The automated computing machinery of claim 9 further comprising the processor

further programmed to:

count the number of messages sent to at least one market during a period of time, including storing in computer memory the number of messages sent to the market during the period of time;

count the number of responses received from the market during the period of time, including storing in computer memory the number of responses received from the market during the period of time; and

display, in addition to the identity of the market and the latency for the market, the number of messages sent to the market and the number of responses received from the market during the period of time.

16. The automated computing machinery of claim 9 further comprising the processor further programmed to:

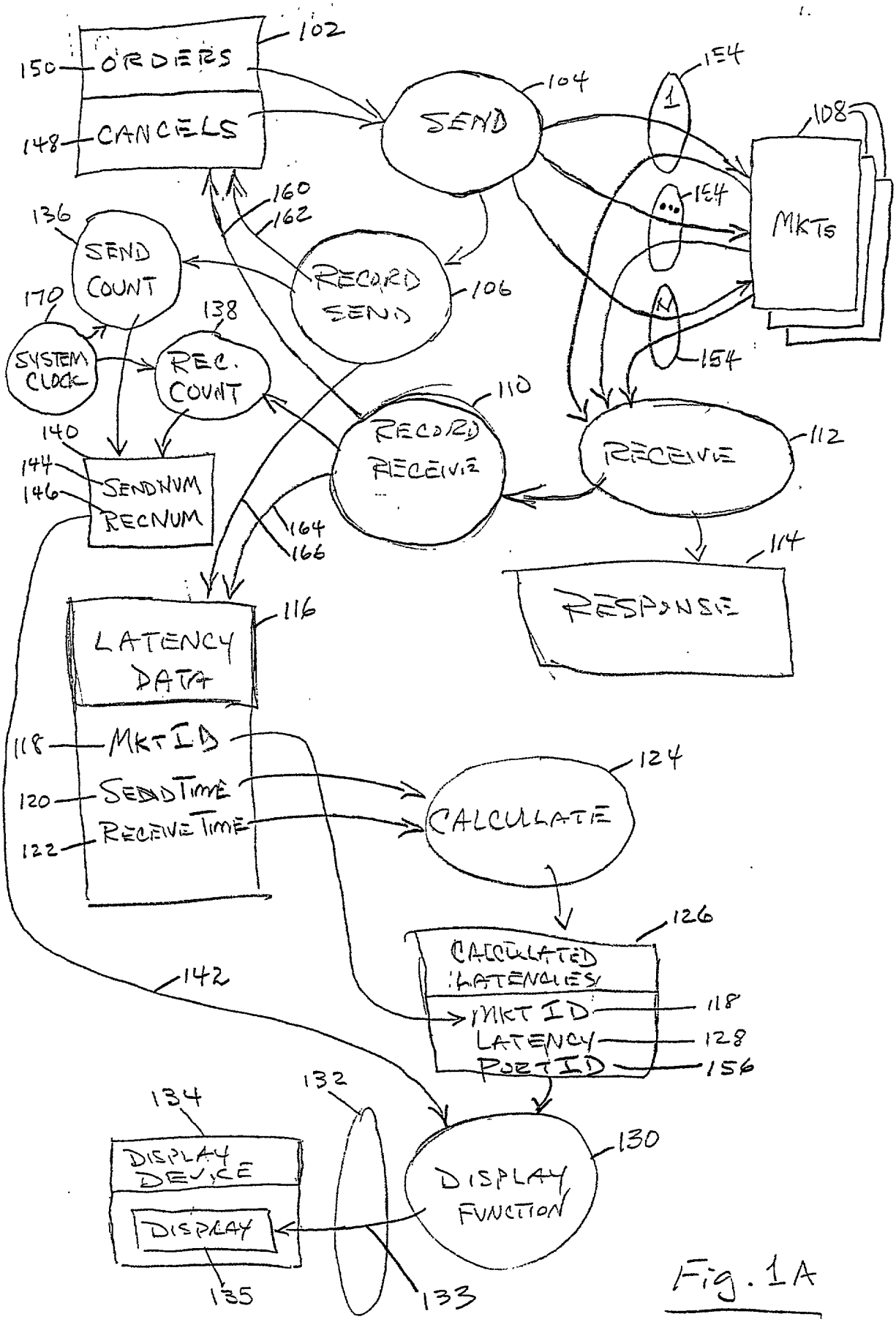
count the number of messages sent to a market through a port during a period of time, including storing in computer memory the number of messages sent to the market through the port during the period of time;

count the number of responses received from the market through the port during the period of time, including storing in computer memory the number of responses received from the market through the port during the period of time; and

display, in addition to the identity of the market and the latency for the market, the number of messages sent to the market through the port and the number of responses received from the market through the port during the period of time.

ABSTRACT

Method and system for displaying latency, useful in broker-dealer computer systems engaged generally in automated processing of orders for securities including sending to markets messages comprising orders and cancellations and receiving from markets responses to orders and cancellations, including recording for messages sent to markets the time when each message is sent and the identity of the market to which each message is sent, including recording for responses received from markets the time when each response is received, wherein each response corresponds to a particular message. Embodiments include calculating latencies for markets dependent upon recorded time when a message is sent to the market and a recorded time when a corresponding response is received from the market. Latencies are embodied alternatively as instant values or various kinds of averages. Embodiments includes latencies for communications ports as well as for markets. Embodiments include counting messages and responses for markets and for ports, and displaying the counts. Embodiments include displaying the identity of the markets and the latencies for the markets.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CANCELS
SEND
MKTS
SEND COUNT
RECORD SEND
SYSTEM CLOCK
REC. COUNT
RECORD RECEIVE
RECEIVE
SENDNUM
RECNUM
RESPONSE
LATENCY DATA
MKT ID
SEND TIME
RECEIVE TIME
CALCULATE
CALCULATED LATENCIES
MKT ID
LATENCY
PORT ID
DISPLAY DEVICE
DISPLAY
DISPLAY FUNCTION
102
104
106
108
110
112
114
116
118
120
122
124
126
128
130
132
133
134
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144
146
148
150
154
156
160
162
164
166
170

Fig. 1A

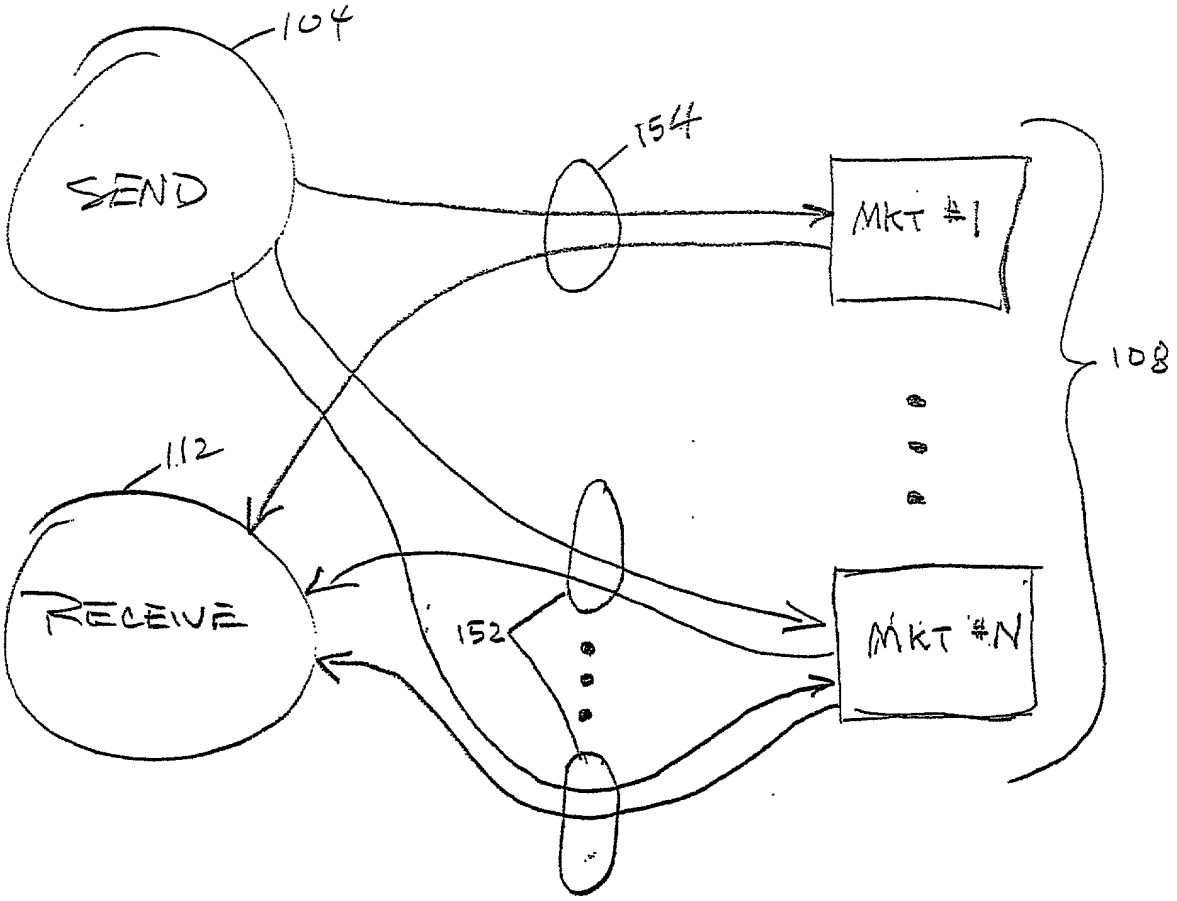
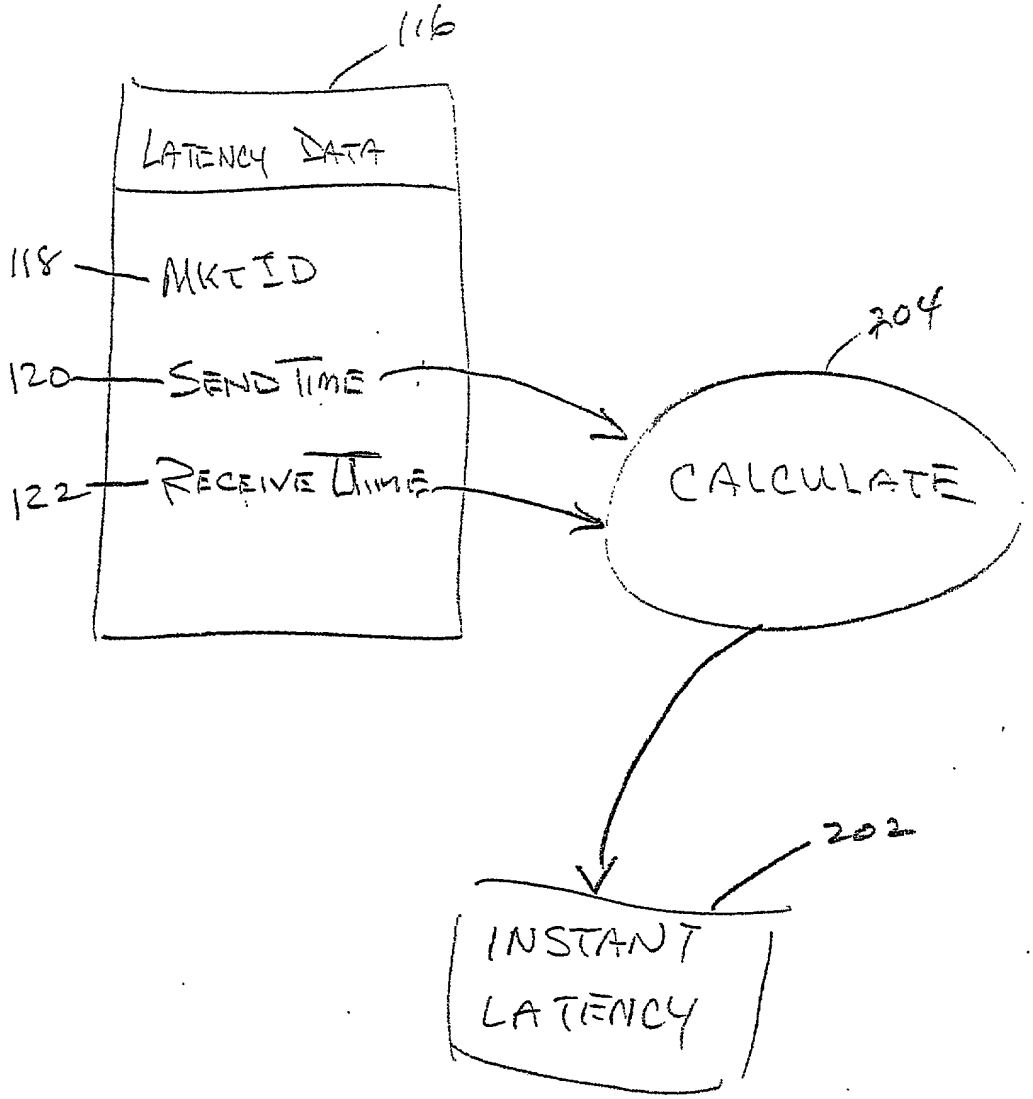


Fig. 1B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MKT ID
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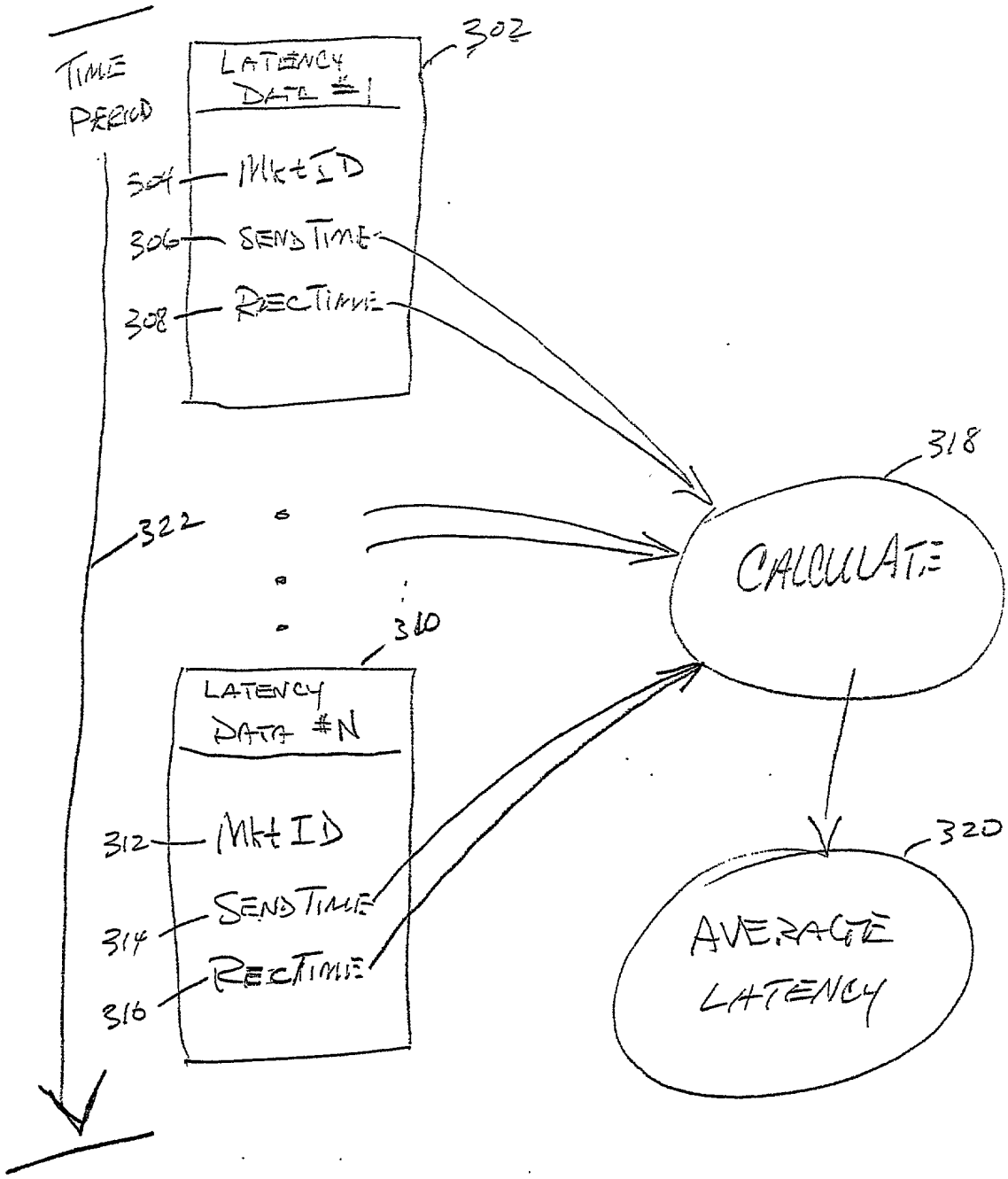
SEND TIME
122
RECEIVE TIME
204
CALCULATE
202
INSTANT
LATENCY

Fig. 2


TIME PERIOD
LATENCY DATA #1
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304
MktID
306
SendTime
308
RecTime
322
318
CALCULATE
LATENCY DATA #N
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312
MktID
314
SendTime
316
RecTime
320
AVERAGE LATENCY

Fig. 3

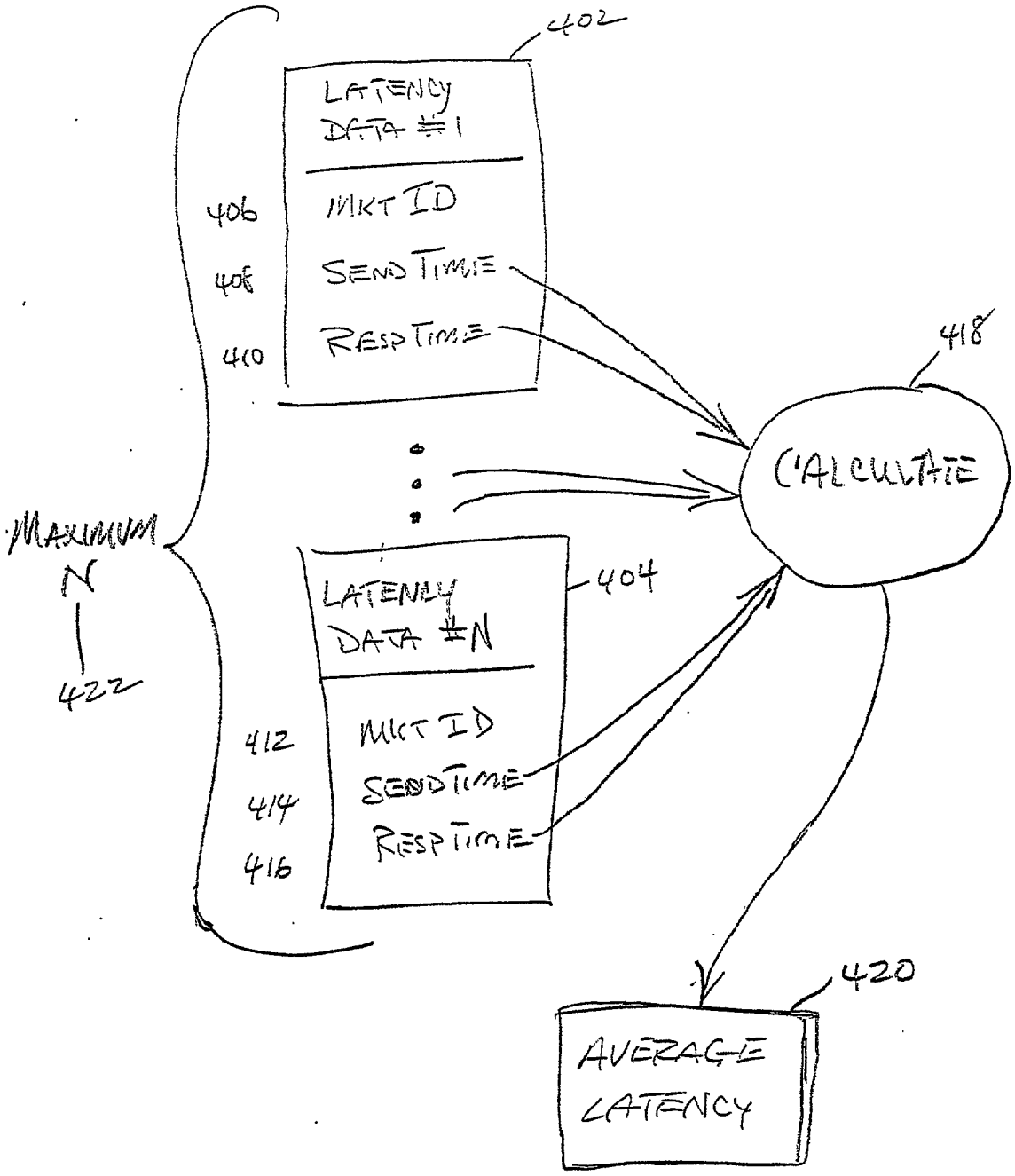

402
LATENCY DATA #1
406
MKT ID
408
SEND TIME
410
RESP TIME
418
CALCULATE
MAXIMUM N
422
LATENCY DATA #N
404
412
MKT ID
414
SEND TIME
416
RESP TIME
420
AVERAGE LATENCY

Fig. 4

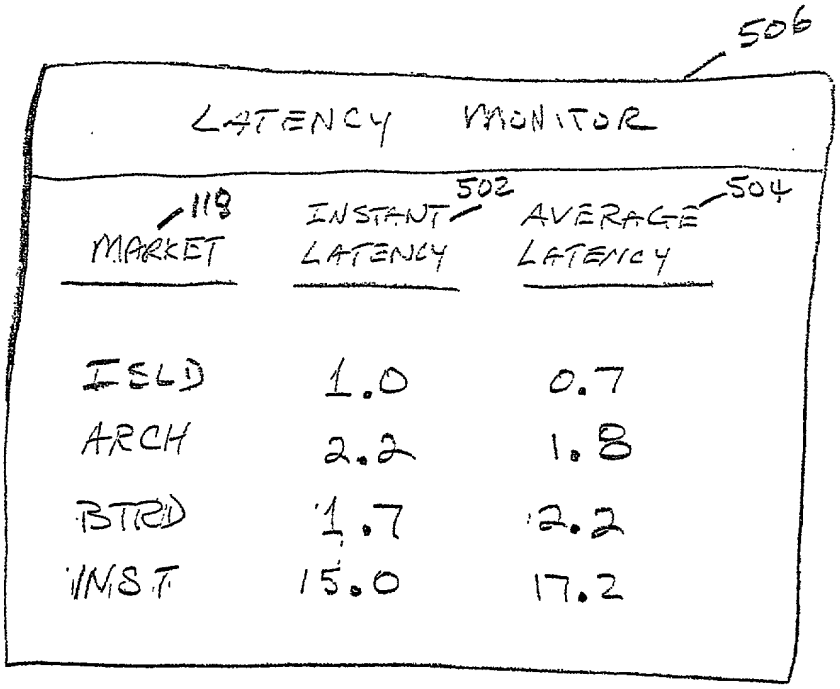


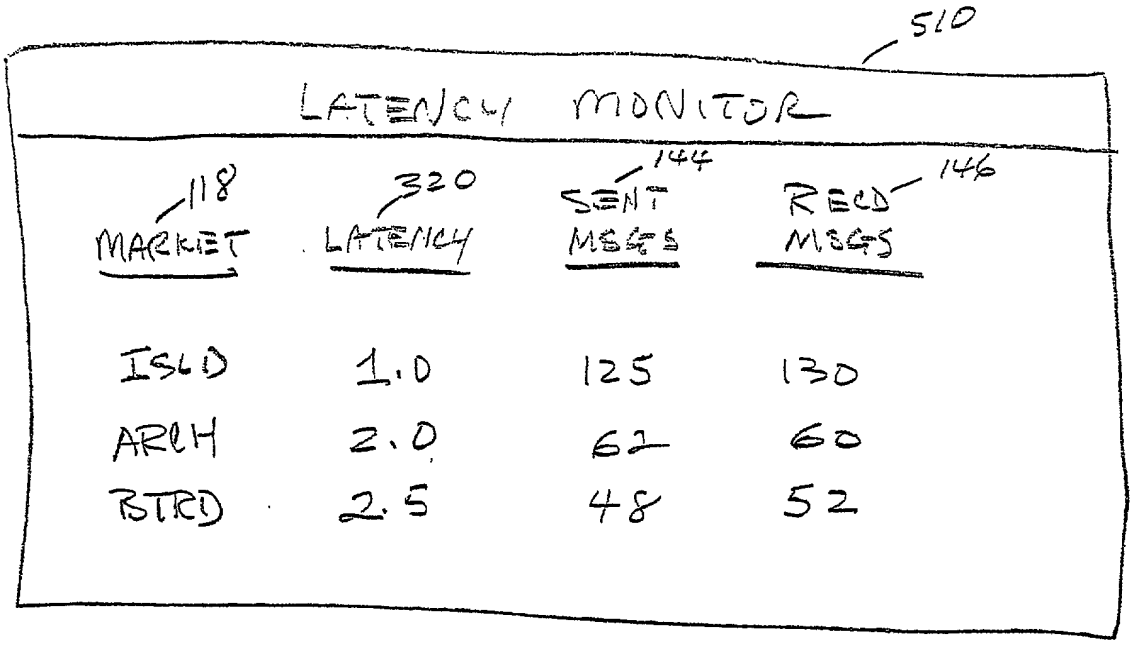
Fig. 5A

508

LATENCY MONITOR

118 MARKET	154 PORT	202 INSTANT LATENCY	320 AVERAGE LATENCY	144 SENT MESSAGES	146 RECD MESSAGES
ISLD	010	1.0	0.7	123	127
ISLD	020	1.2	0.8	140	145
ARCH	010	2.3	2.0	70	80
ARCH	020	2.5	2.2	75	78
INST	010	15.0	18.1	5	8
INST	020	17.3	17.5	4	7
INST	030	18.7	19.2	6	6

Fig. 5B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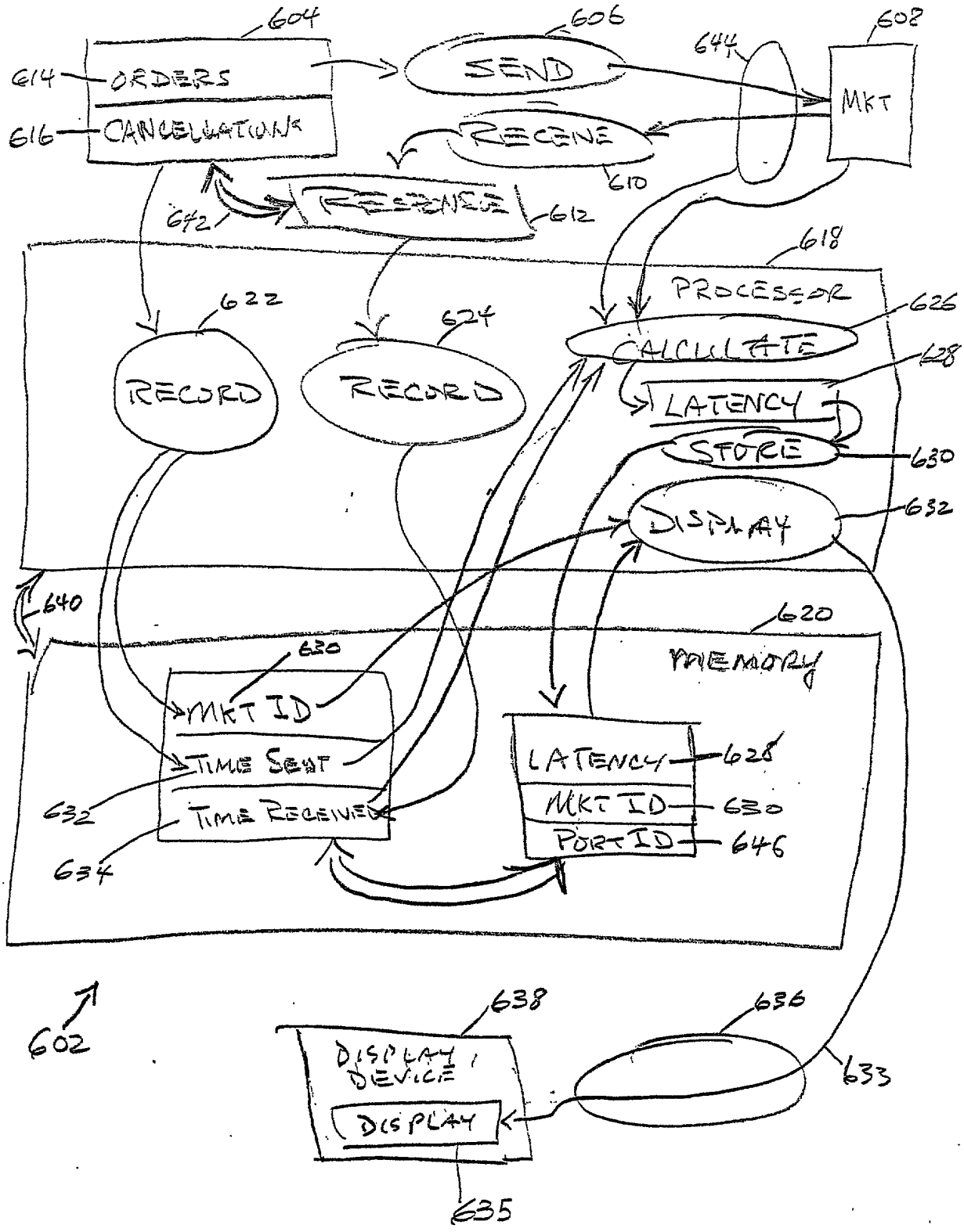
LATENCY MONITOR
118
MARKET
320
LATENCY
144
SENT MSGS
146
RECD MSGS
ISLD 1.0 125 130
ARCH 2.0 62 60
BTRD 2.5 48 52

Fig. 5C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606
608
644
614
ORDERS
SEND
MKT
616
CANCELLATIONS
RECEIVE
610
642
RECEIVE
612
618
PROCESSOR
622
624
626
RECORD
RECORD
CALCULATE
628
LATENCY
STORE
630
DISPLAY
632
640
620
MEMORY
620
MKT ID
TIME SENT
632
TIME RECEIVED
634
LATENCY
628
MKT ID
630
PORT ID
646
602
638
636
633
DISPLAY DEVICE
DISPLAY
635

Fig. 6

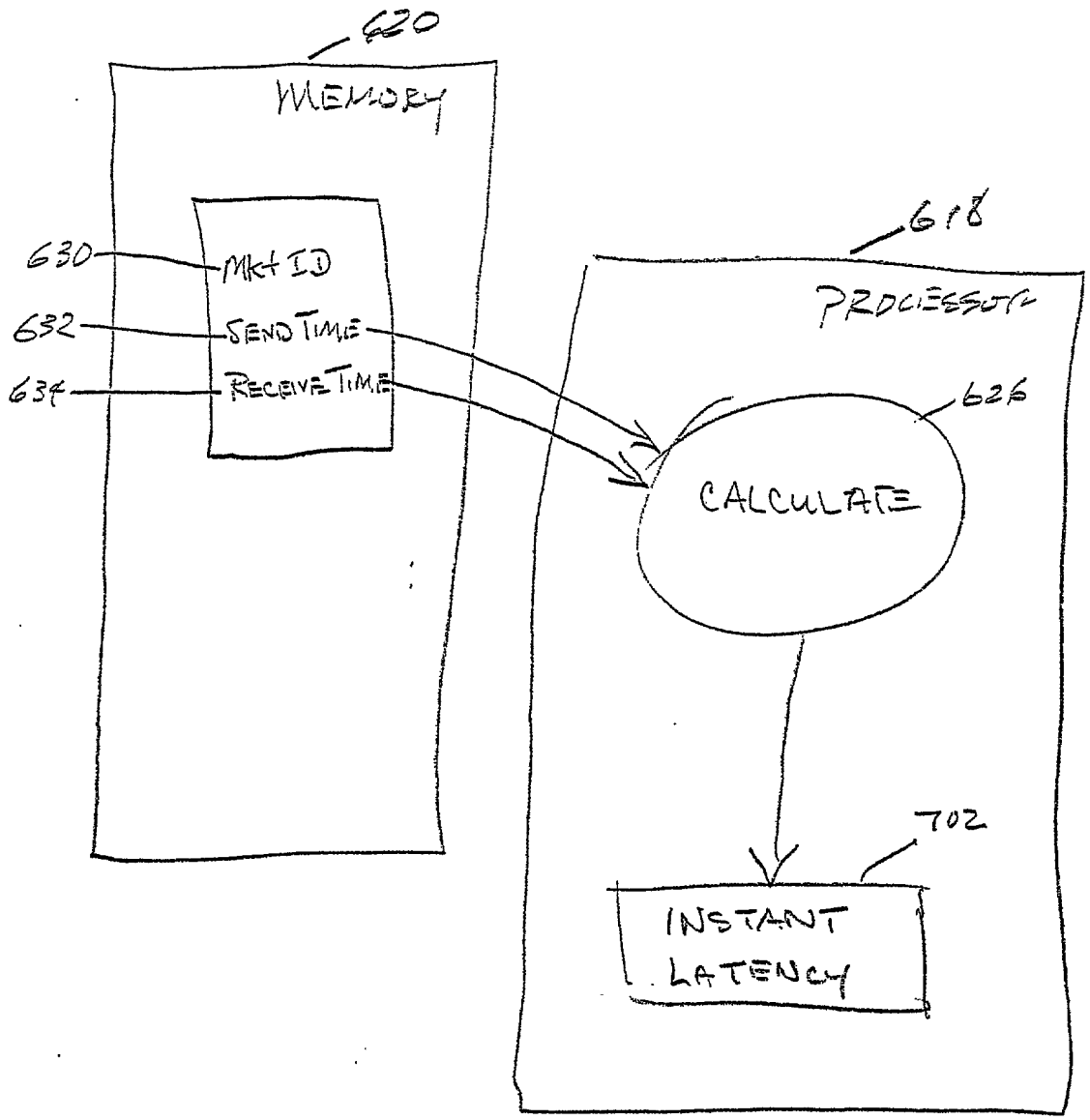
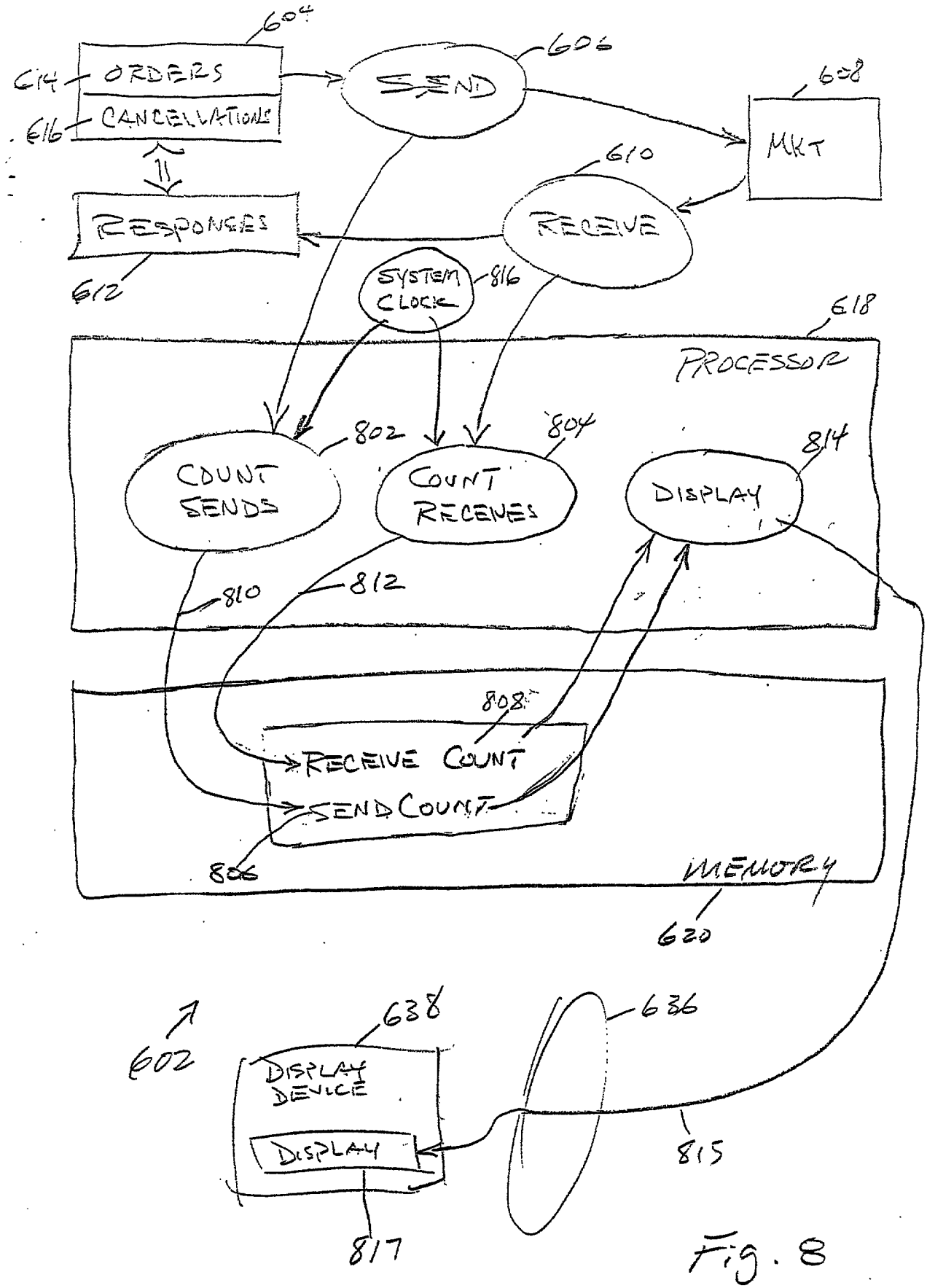

620
MEMORY
630
MKT ID
632
SEND TIME
634
RECEIVE TIME
618
PROCESSOR
626
CALCULATE
702
INSTANT LATENCY

Fig. 7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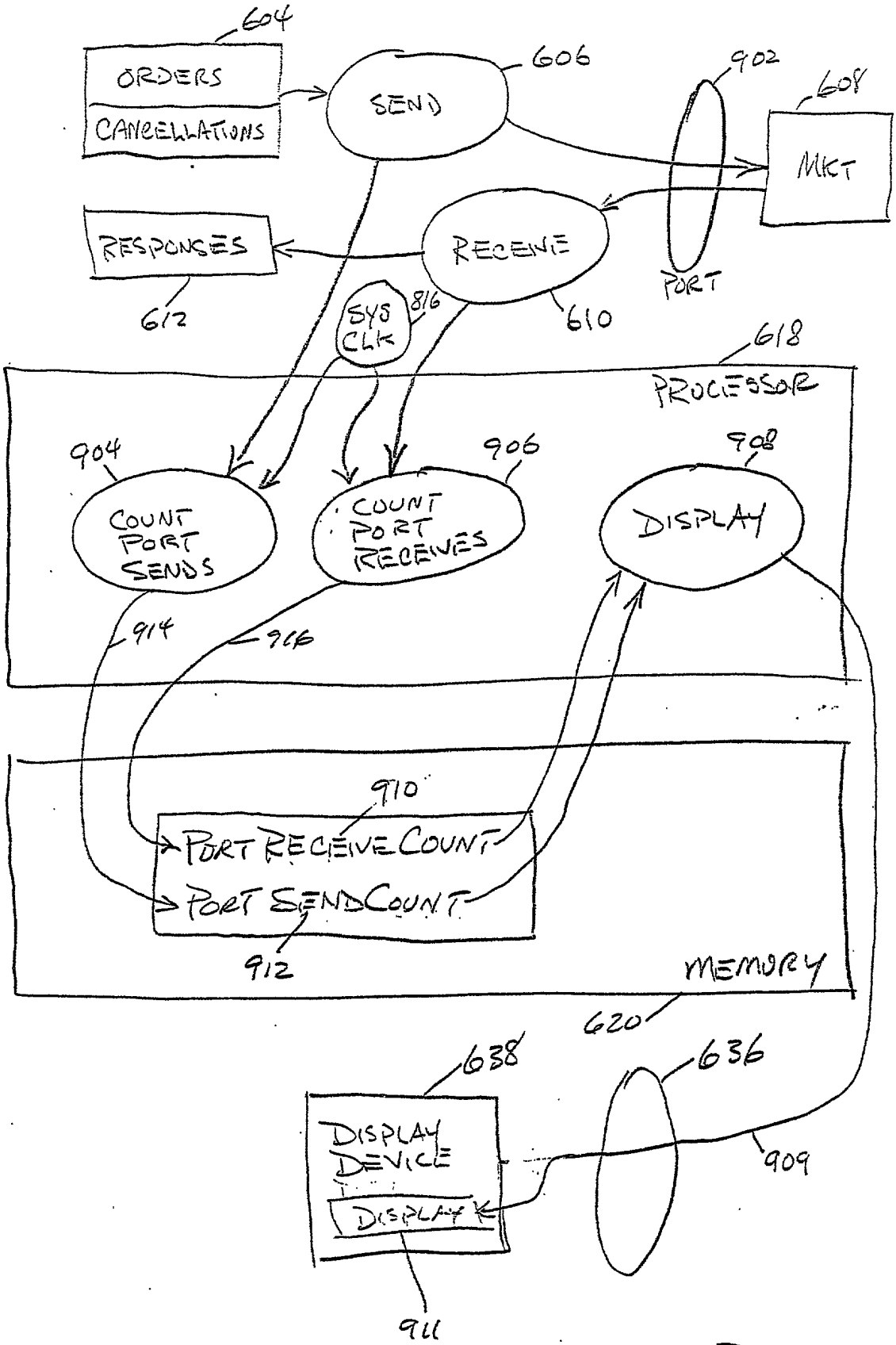
ORDERS
616
CANCELLATIONS
606
SEND
608
MKT
610
RECEIVE
612
RESPONSES
SYSTEM CLOCK
816
618
PROCESSOR
802
804
814
COUNT SENDS
COUNT RECEIVES
DISPLAY
810
812
808
RECEIVE COUNT
SEND COUNT
806
MEMORY
620
602
638
636
DISPLAY DEVICE
DISPLAY
815
817

Fig. 8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ORDERS
CANCELLATIONS
606
SEND
902
608
MKT
RESPONSES
612
RECEIVE
610
PORT
SYS CLK
816
618
PROCESSOR
904
COUNT PORT SENDS
906
COUNT PORT RECEIVES
908
DISPLAY
914
916
910
PORT RECEIVE COUNT
PORT SENDCOUNT
912
MEMORY
620
638
636
DISPLAY DEVICE
DISPLAY
909
911

Fig. 9

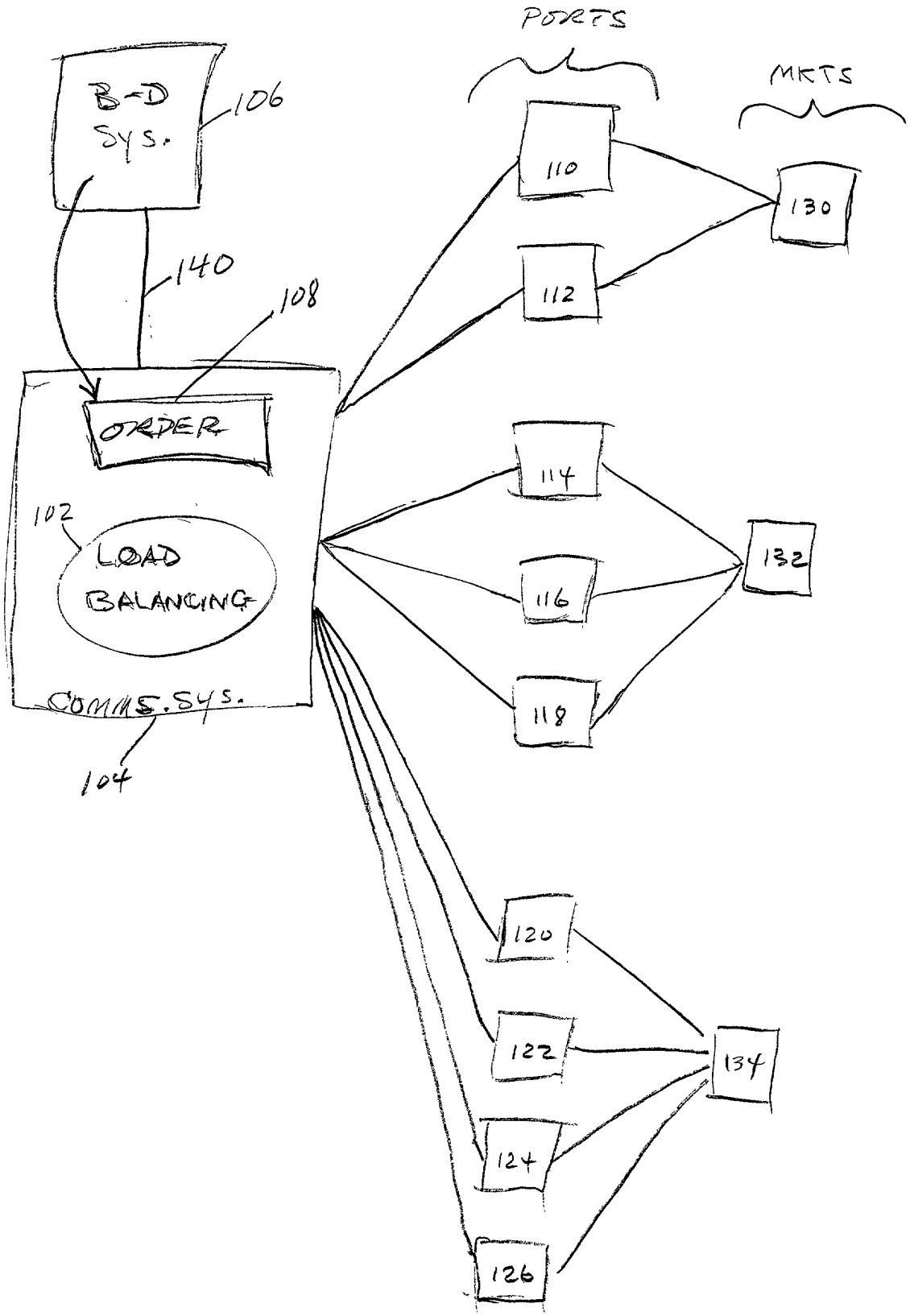

PORTS
MKTS
B-D SYS.
106
110
130
140
112
108
ORDER
114
102
LOAD BALANCING
132
116
COMMS. SYS.
118
104
120
122
134
124
126

Fig. 1

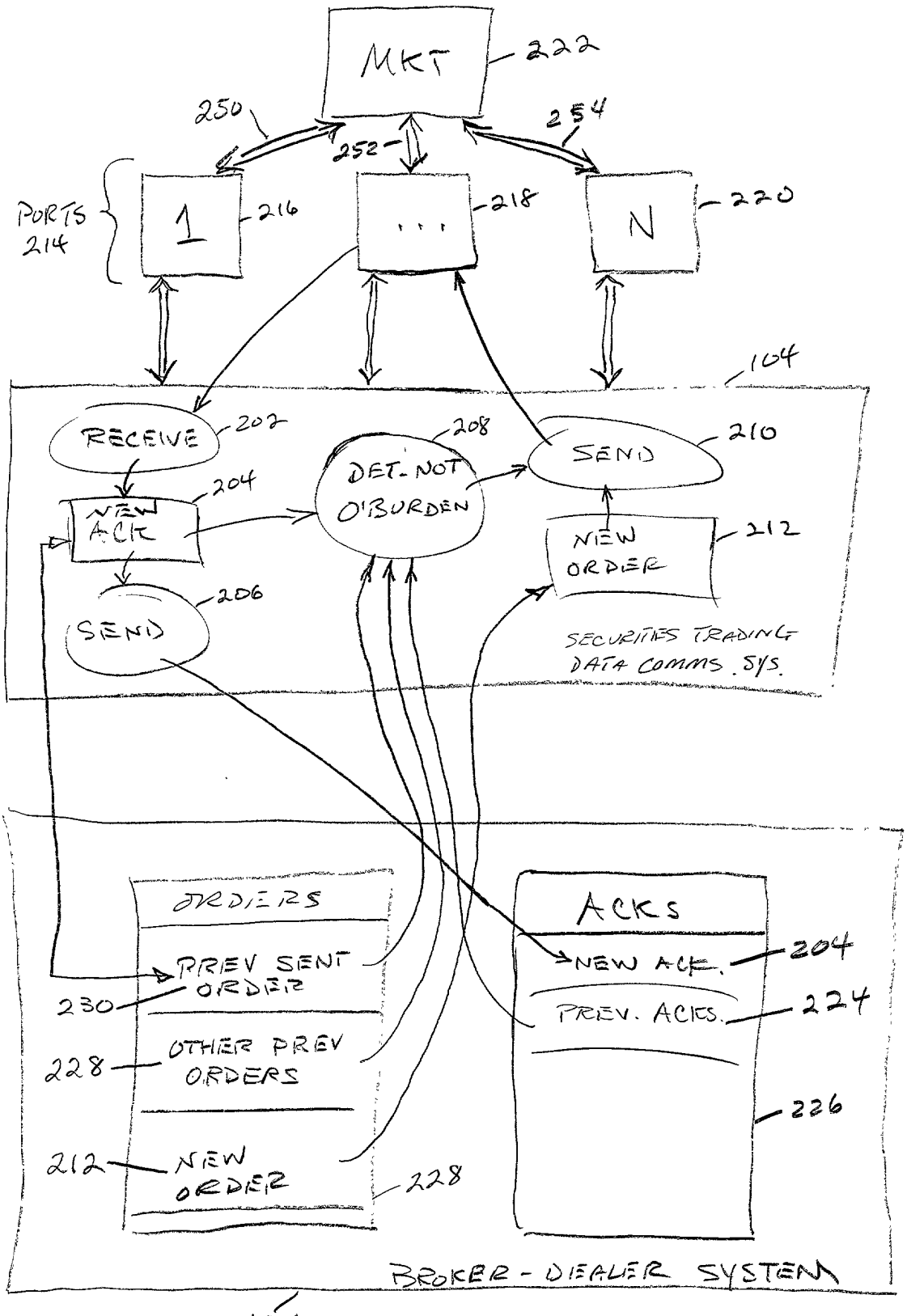
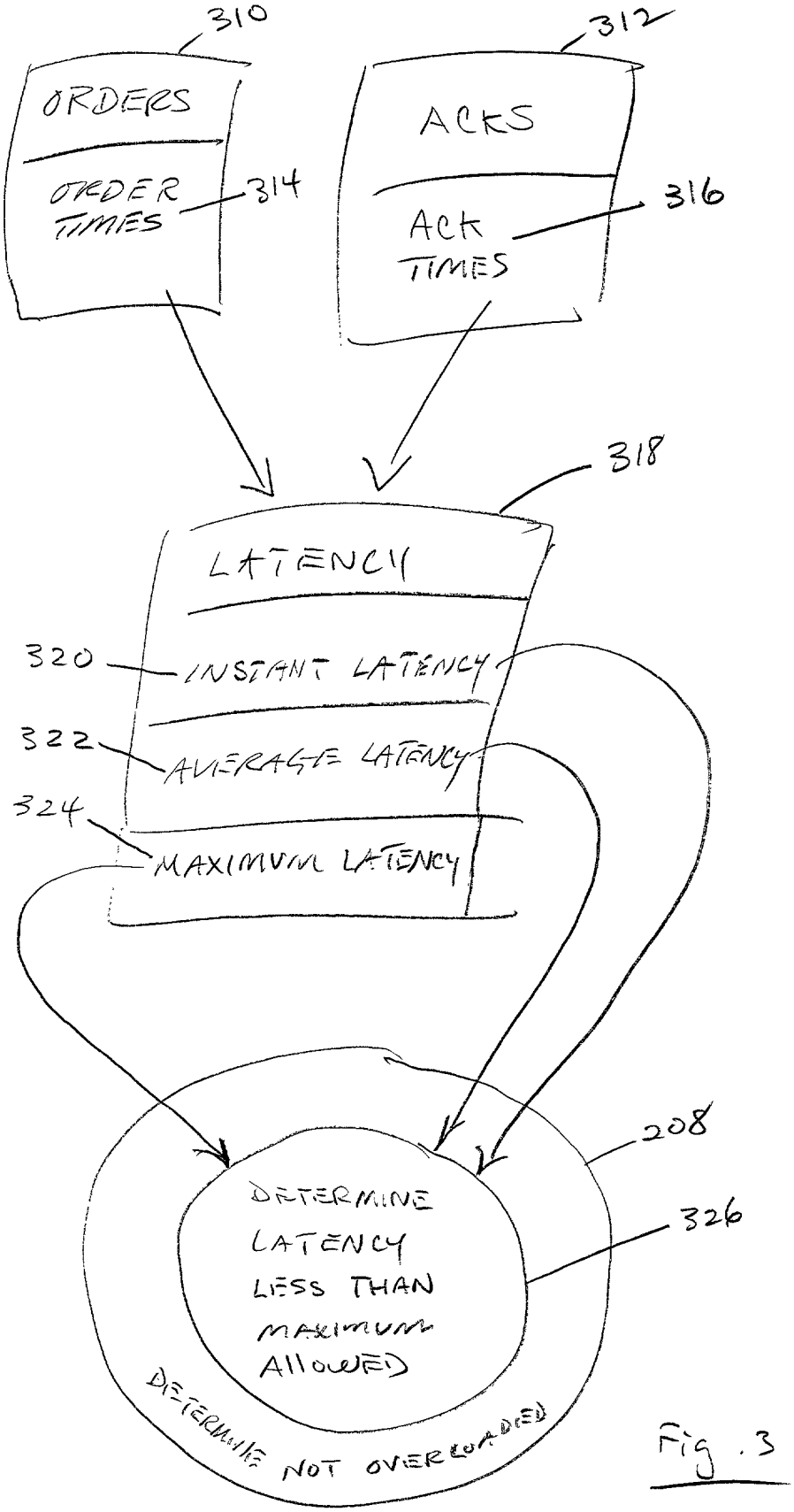

MKT
222
250
252
254
PORTS
214
1
216
...
218
N
220
104
RECEIVE
202
DET. NOT
O'BURDEN
208
SEND
210
NEW
ACK
204
NEW
ORDER
212
SEND
206
SECURITIES TRADING
DATA COMMS. SYS.
ORDERS
ACKS
PREV SENT
ORDER
230
NEW ACK.
204
PREV. ACKS.
224
OTHER PREV
ORDERS
228
226
212
NEW
ORDER
228
BROKER - DEALER SYSTEM
106

Fig. 2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ORDERS
ORDER TIMES
314
312
ACKS
ACK TIMES
316
318
LATENCY
320
INSTANT LATENCY
322
AVERAGE LATENCY
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MAXIMUM LATENCY
208
DETERMINE LATENCY LESS THAN MAXIMUM ALLOWED
326
DETERMINE NOT OVERLOADED

Fig. 3

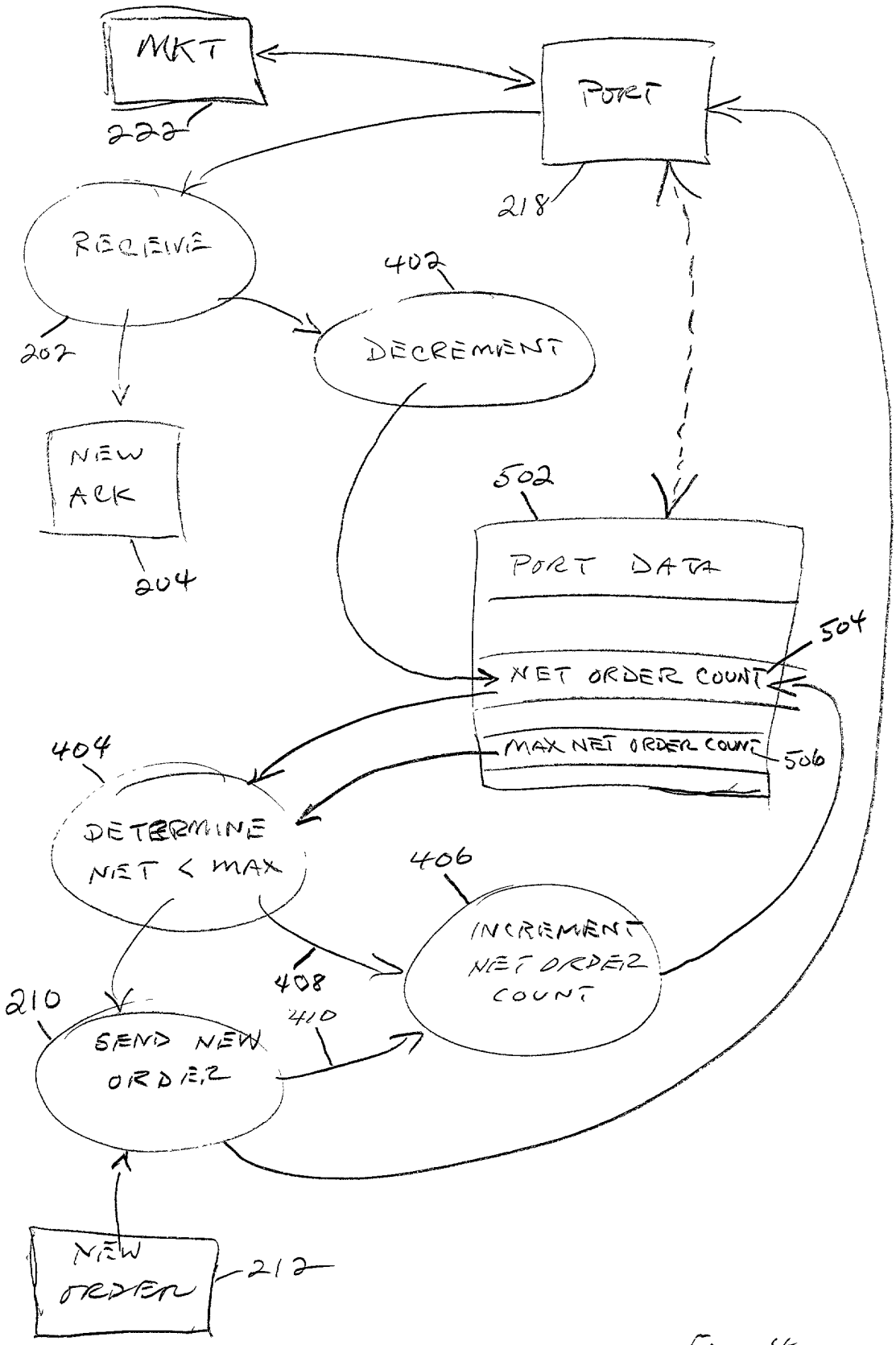
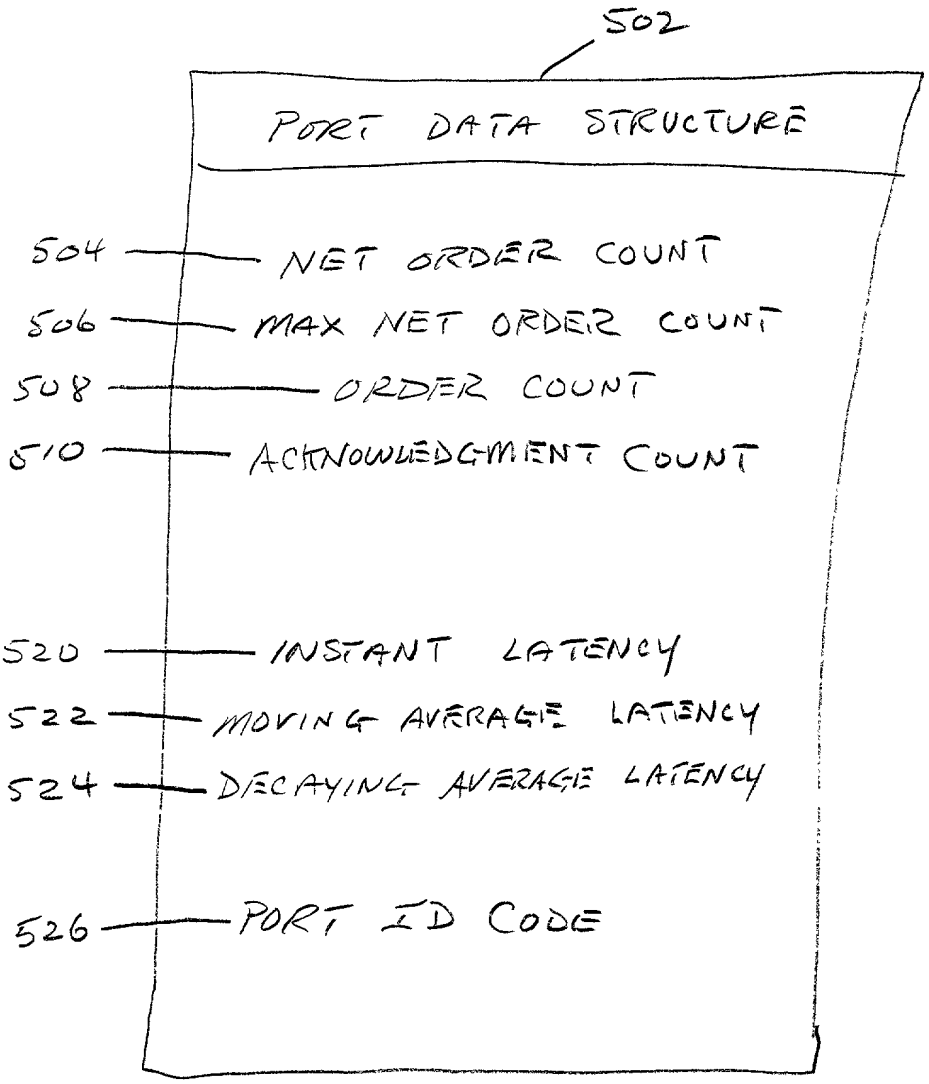

MKT
222
PORT
218
RECEIVE
202
402
DECREMENT
NEW ACK
204
502
PORT DATA
504
NET ORDER COUNT
MAX NET ORDER COUNT
506
404
DETERMINE NET < MAX
406
INCREMENT NET ORDER COUNT
408
410
210
SEND NEW ORDER
NEW ORDER
212

Fig. 4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NET ORDER COUNT
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MAX NET ORDER COUNT
508
ORDER COUNT
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ACKNOWLEDGMENT COUNT
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INSTANT LATENCY
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DECAYING AVERAGE LATENCY
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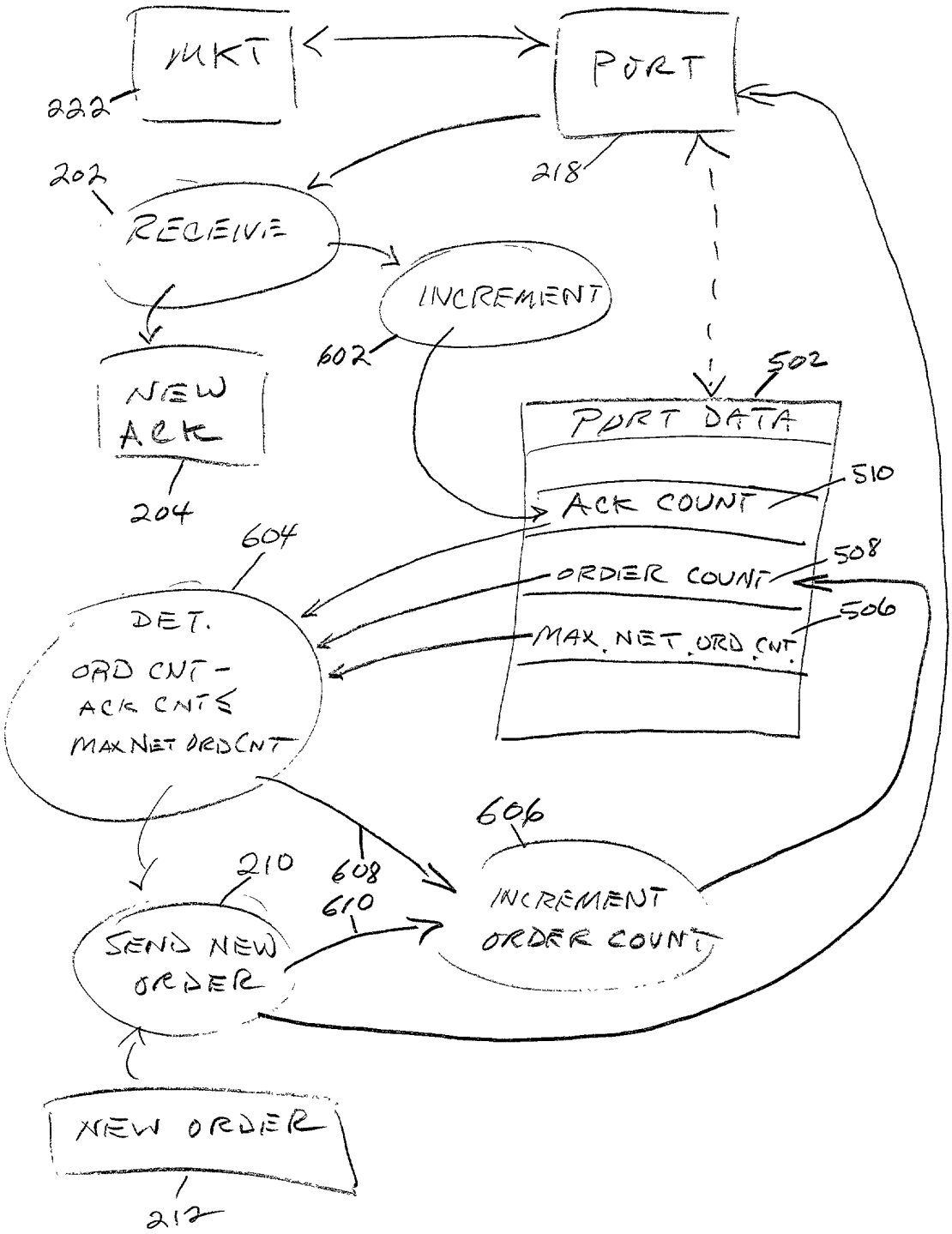
PORT ID CODE

Fig. 5


MKT
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PORT
218
202
RECEIVE
INCREMENT
602
NEW ACK
204
502
PORT DATA
ACK COUNT
510
ORDER COUNT
508
MAX. NET. ORD. CNT.
506
604
DET.
ORD CNT - ACK CNT ≤ MAX NET ORD CNT
606
608
610
210
SEND NEW ORDER
INCREMENT ORDER COUNT
NEW ORDER
212

Fig. 6

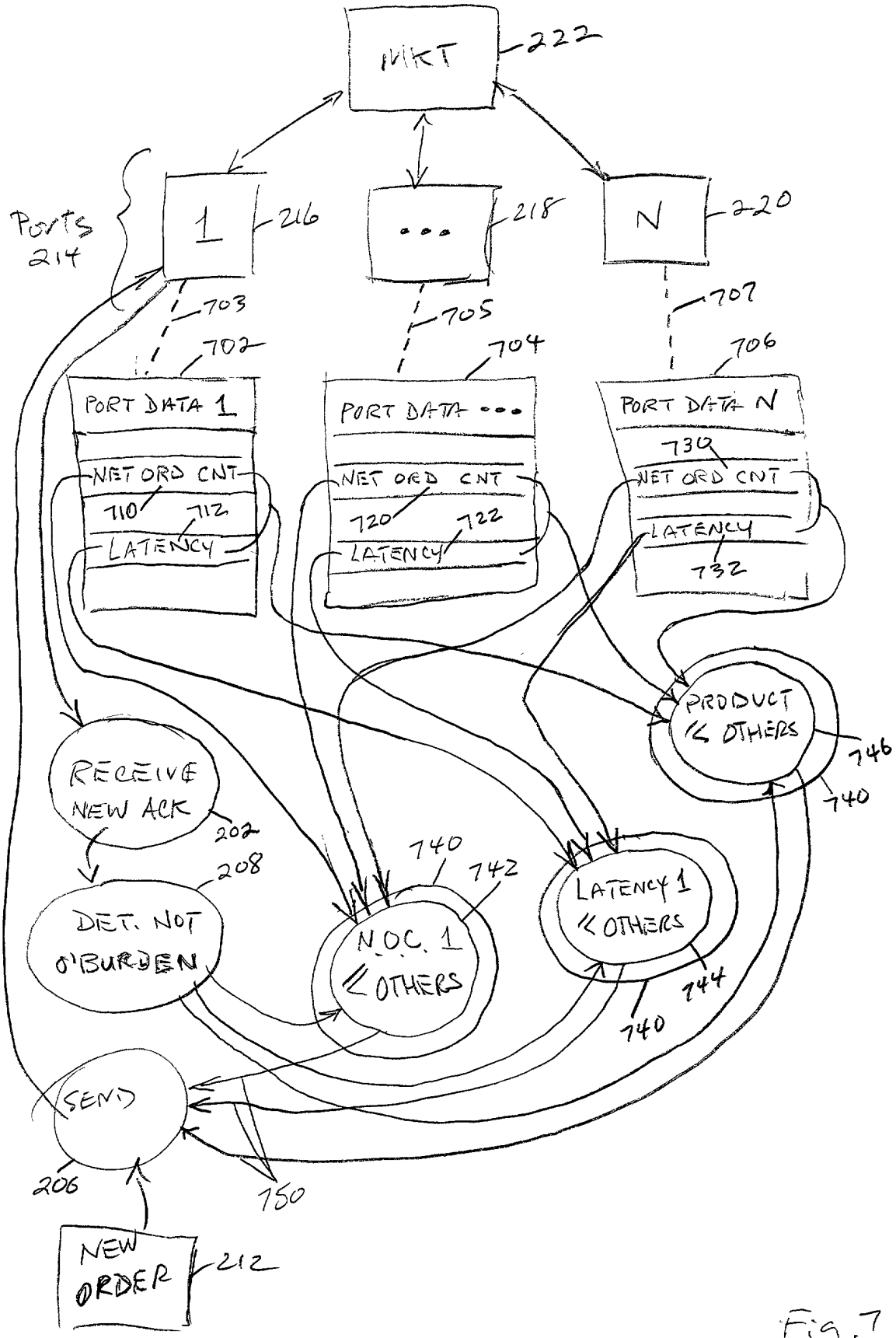
NRT
222
Ports
214
1
216
...
218
N
220
703
705
707
702
704
706
PORT DATA 1
PORT DATA ...
PORT DATA N
730
NET ORD CNT
710
712
LATENCY
NET ORD CNT
720
722
LATENCY
NET ORD CNT
LATENCY
732
PRODUCT
< OTHERS
746
740
RECEIVE
NEW ACK
202
208
DET. NOT
O'BURDEN
740
742
N.O.C. 1
< OTHERS
LATENCY 1
< OTHERS
744
740
SEND
206
150
NEW
ORDER
212

Fig. 7

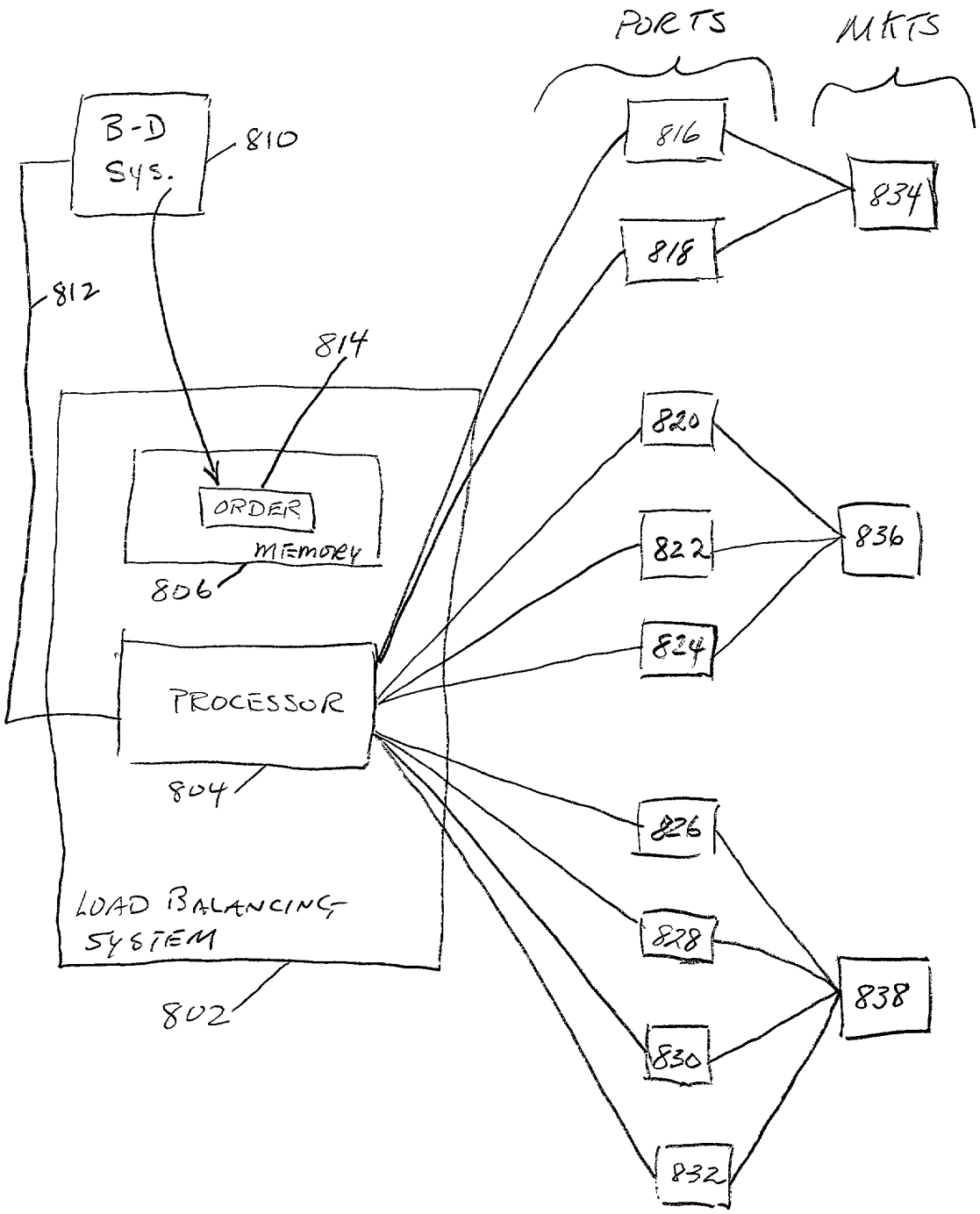
PORTS
MKTS
B-D
SYS.
810
812
814
816
818
834
820
822
824
836
ORDER
MEMORY
806
PROCESSOR
804
826
828
838
830
832
LOAD BALANCING
SYSTEM
802

Fig. 8

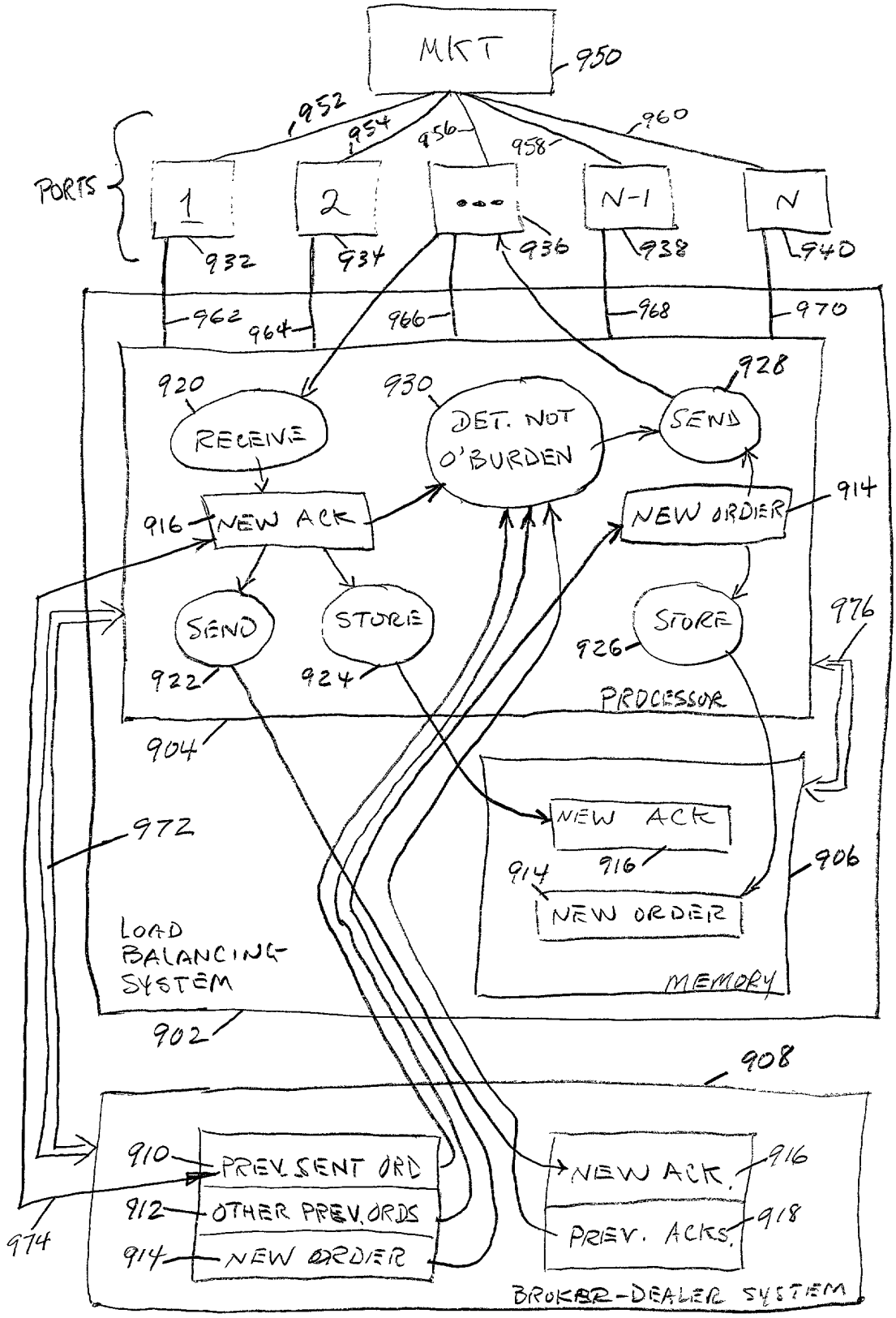
MRT
950
952
954
956
958
960
PORTS
1
2
N-1
N
932
934
936
938
940
962
964
966
968
970
920
930
928
RECEIVE
DET. NOT O'BURDEN
SEND
914
916
NEW ACK
NEW ORDER
SEND
STORE
STORE
976
922
924
926
PROCESSOR
904
NEW ACK
916
914
906
NEW ORDER
MEMORY
972
LOAD BALANCING SYSTEM
902
908
910
PREV. SENT ORD
912
OTHER PREV. ORDS
914
NEW ORDER
NEW ACK.
916
PREV. ACKS.
918
974
BROKER-DEALER SYSTEM

Fig. 9

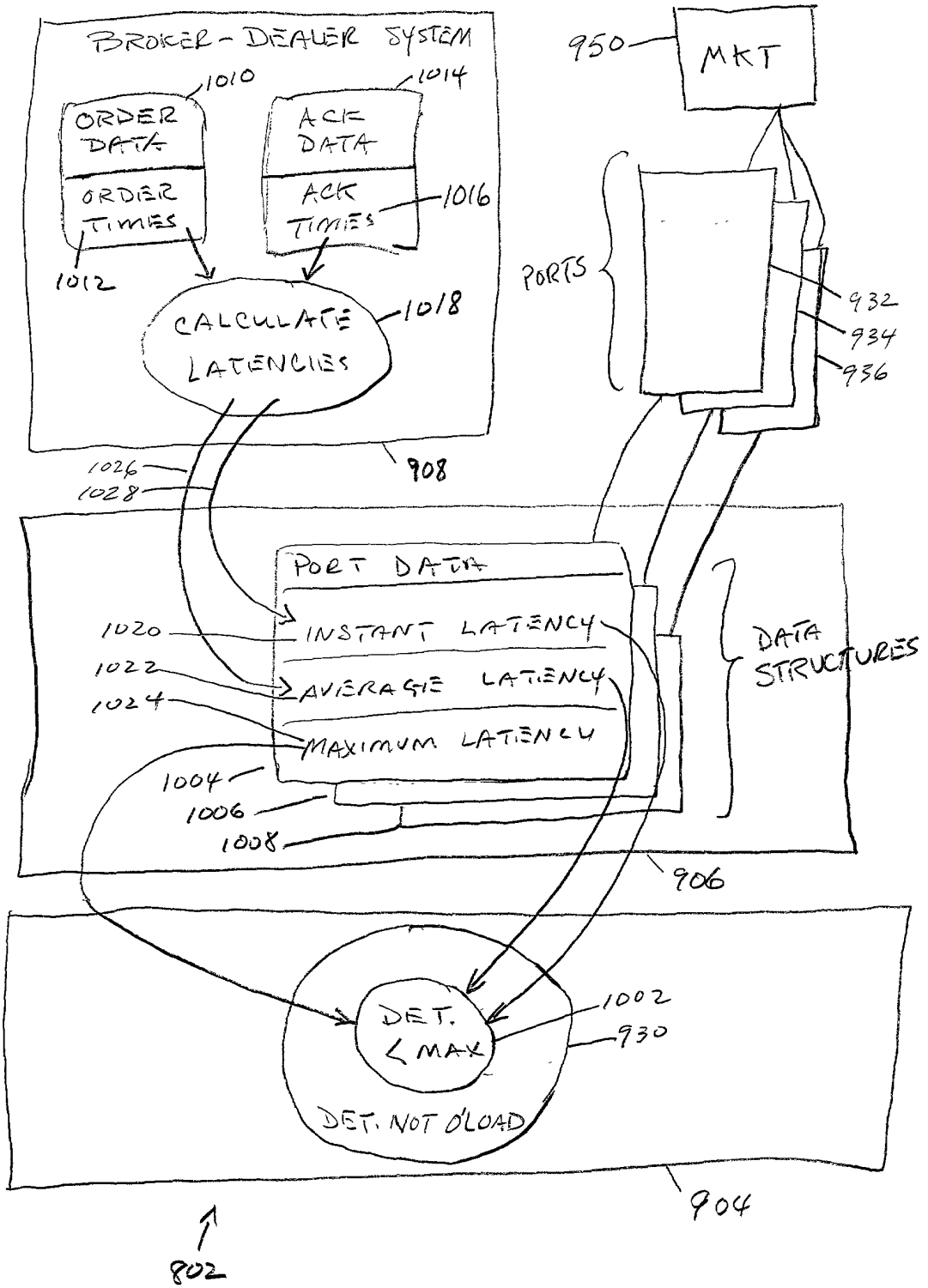
BROKER-DEALER SYSTEM
1010
ORDER DATA
ORDER TIMES
1012
1014
ACK DATA
ACK TIMES
1016
CALCULATE LATENCIES
1018
908
950
MKT
PORTS
932
934
936
1026
1028
PORT DATA
INSTANT LATENCY
AVERAGE LATENCY
MAXIMUM LATENCY
1020
1022
1024
1004
1006
1008
DATA STRUCTURES
906
DET. L MAX
1002
930
DET. NOT O'LOAD
904
802

Fig. 10

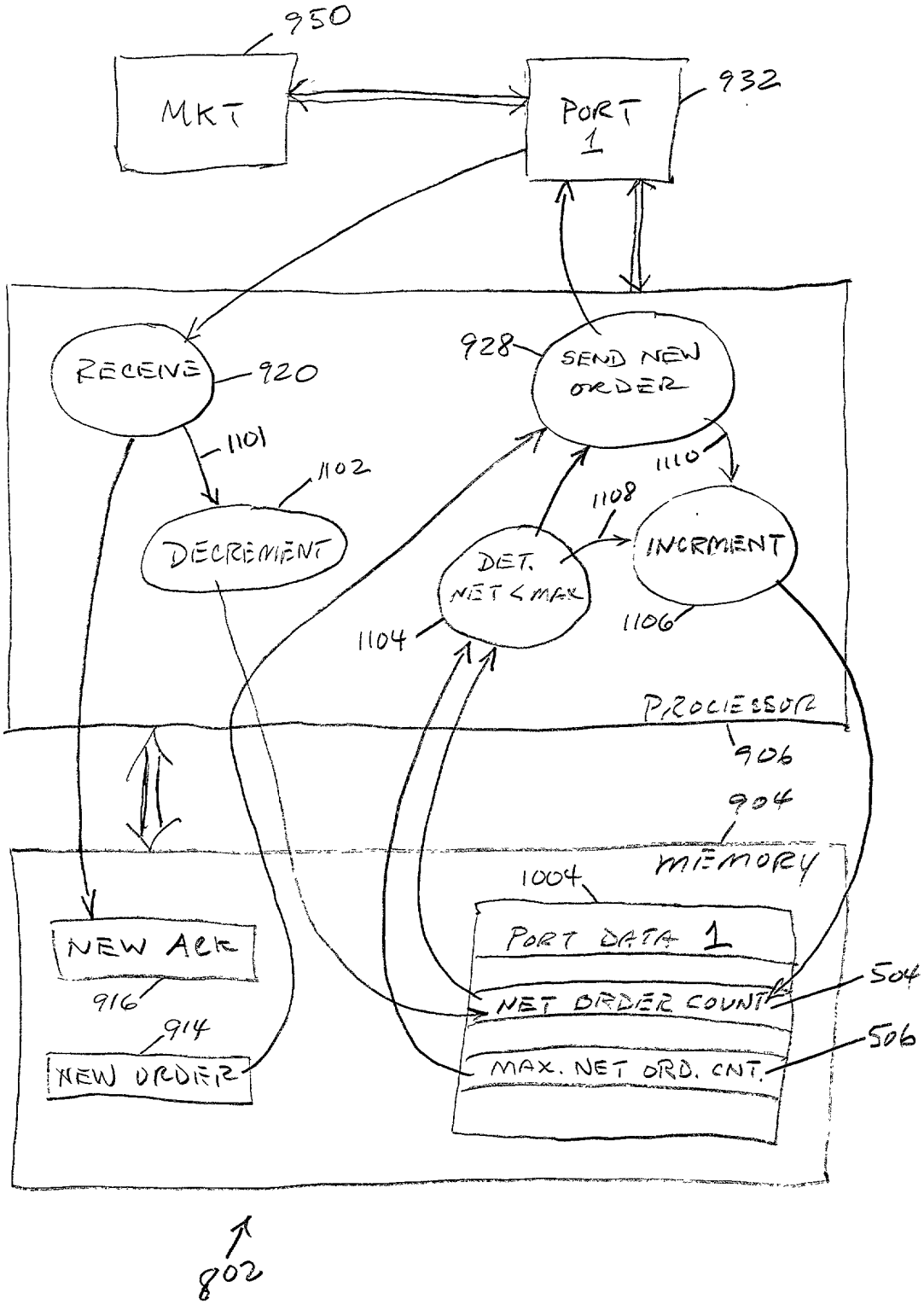
950
MKT
PORT 1
932
RECEIVE
920
928
SEND NEW ORDER
1101
1102
DECREMENT
1110
1108
INCRMENT
DET. NET < MAX
1104
1106
PROCESSOR
906
904
MEMORY
1004
PORT DATA 1
NET ORDER COUNT
504
MAX. NET ORD. CNT.
506
NEW ACK
916
914
NEW ORDER
802

Fig. 11

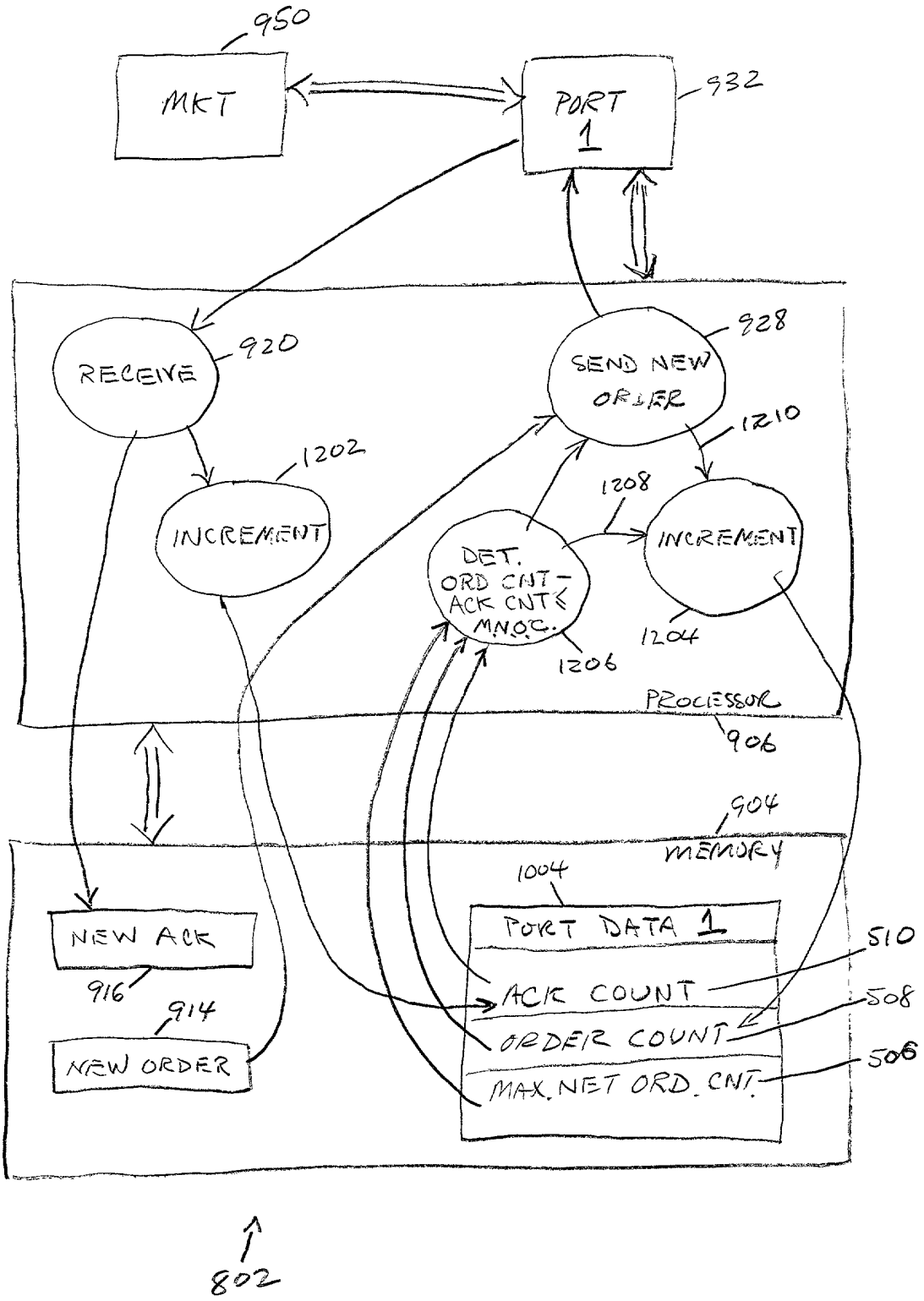
950
MKT
PORT 1
932
RECEIVE
920
928
SEND NEW ORDER
1210
1202
INCREMENT
1208
DET. ORD CNT - ACK CNT ≤ M.N.O.C.
INCREMENT
1206
1204
PROCESSOR
906
904
MEMORY
1004
PORT DATA 1
NEW ACK
916
914
NEW ORDER
ACK COUNT
510
ORDER COUNT
508
MAX. NET ORD. CNT.
506
802

Fig. 12

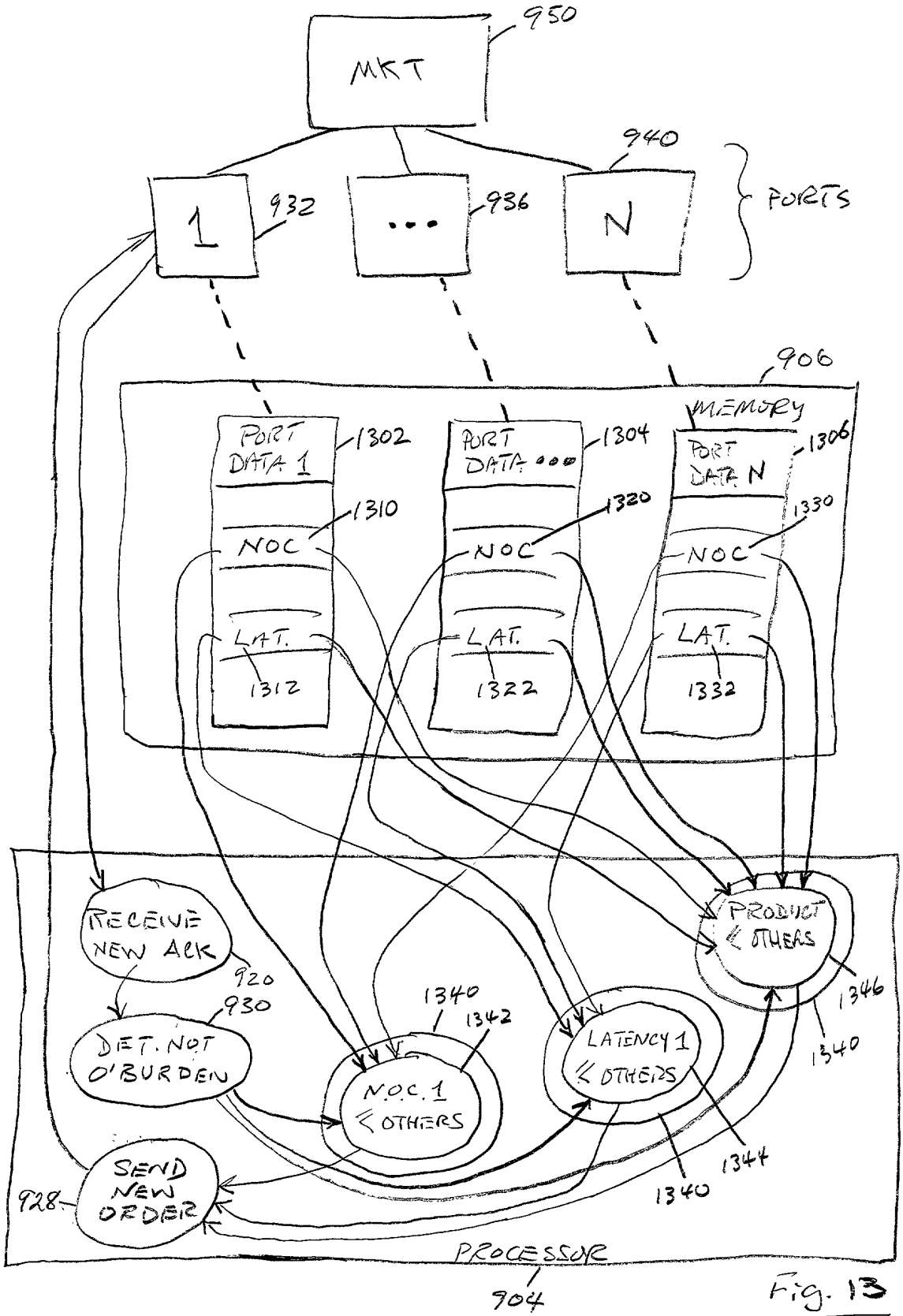
MKT
950
940
1
932
...
936
N
PORTS
906
MEMORY
PORT DATA 1
1302
PORT DATA ...
1304
PORT DATA N
1306
NOC
1310
NOC
1320
NOC
1330
LAT.
1312
LAT.
1322
LAT.
1332
RECEIVE NEW ACK
920
DET. NOT O'BURDEN
930
N.O.C. 1 < OTHERS
1340
1342
LATENCY 1 < OTHERS
PRODUCT < OTHERS
1346
1340
1344
1340
SEND NEW ORDER
928
PROCESSOR
904

Fig. 13

COMBINED DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled

APPARATUS AND METHOD FOR LOAD BALANCING AMONG DATA COMMUNICATIONS PORTS IN AUTOMATED SECURITIES TRADING SYSTEMS

the specification of which: (check one) ■ is attached hereto.
☐ was filed on _____
Attorney Docket No. T30411US

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known by me which is material to the patentability of this application in accordance with Title 37, Code of Federal Regulations §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed: **NONE**

Prior Foreign Application(s):

(Number)		(Country)	(Day/Month/Year Filed)
(Number)		(Country)	(Day/Month/Year Filed)
(Number)		(Country)	(Day/Month/Year Filed)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) or PCT international application(s) designating the United States of America that is/are listed below, and insofar as the subject matter of each of the claims of this application is not disclosed in that/those prior application(s) in this manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §156 which became available between the filing date of the prior application and the national or PCT international filing date of this application: **NONE**

(Application Serial No.)		(Filing Date)	(Status: pending, patented, abandoned)
(Application Serial No.)		(Filing Date)	(Status. pending, patented, abandoned)

I hereby appoint the following attorney(s) and/or agent(s): Gordon T. Arnold (Reg. No. 32,395), John R. Biggers (Reg. No. 44,537), Kenneth P. Beyers (Reg. No. 36,409), Jeffrey S. Schubert (Reg. No. 43,098), and H. Artoush Ohanian (Reg. No. 46-022), all of the firm Arnold & Associates, 2603 Augusta, Suite 800, Houston, Texas 77057, telephone number (713) 972-1150, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patents issued thereon.

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